SCIENCE ABSTRACTS.

Section A.—PHYSICS.

DECEMBER, 1928.

GENERAL PHYSICS.

3150. Use of the Astatic Pendulum for the Comparative Measurement of *g*. G. Ising and N. Urelius. *K. Svenska Vetenskapsakad. Handlingar, Stockholm*, 6. 4. *pp.* 1–48, 1928. *In German.*

An astatic pendulum consists of a weight almost in unstable equilibrium under the action of the disturbing force of gravity and some elastic restoring force. Thus, very small variations in *g* cause a perceptible movement of an index attached to the weight. Part I of the present paper contains a general account of some possible types of instrument. In Part II certain instruments that have been constructed and examined are described in detail. The form finally considered most satisfactory consists of a horizontal quartz thread carrying at its centre a vertical pendulum with its bob above the thread. Freedom from zero disturbances is obtained by placing the arrangement on a block of metal which is suspended by two flexible metal bands. Fine adjustable spiral springs attached to this block enable levelling to be carried out with great accuracy. The theory of the instrument is given at length and the various sources of error examined experimentally; the most serious of these is the absorption of atmospheric water vapour by the quartz. The instrument has been used both in Stockholm and Copenhagen and the relative value of *g* obtained agrees closely with that given by the use of an invariable pendulum.

A. A. D.

3151. Plane Strain and Stress in Rotating Elliptic Cylinders and Discs. S. Ghosh. *Cambridge Math. Soc., Bull.* 19. *pp.* 117–126, 1928.

Mathematical. Solutions are obtained satisfying the maximum number of boundary conditions possible with the limitation to plane strain (cylinder) and plane stress (disc). W. G. B.

3152. Study of Turbulence. J. Kozeny. *Akad. Wiss. Wien, Ber.* 137. 2*a*. *No.* 5–6. *pp.* 307–325, 1928.

Considerations are advanced in the paper whereby the conditions of geometrical similarity of comparable stream processes may be determined from which the velocity relationships are then derived. The paper is entirely mathematical and must be read as a whole. H. H. Ho.

3153. Occurrence of Special Oscillations during the Forced Vibrations of a Linear Oscillator. H. Schmidt. *Zeits. f. Phys.* 50. 1–2. *pp.* 153–160, 1928.

This work continues that of three previous papers [see Abstracts 537, 2204 and 2797 (1927)]. It is shown that if a linear harmonic oscillator at rest be subjected from a definite time point to the influence of a disturbing force $K(t)$, which is an analytical function of the time t, then at two places analytically $K(t)$ apart forced special oscillations of the oscillator will be set up. A solution of the oscillation equation is given which expresses these facts explicitly and affords the analytical connection between the forced oscillation and the disturbance function $K(t)$. H. H. Ho.

3154. Theoretical Interpretation of the Experimental Ballistic Curve, F(V)/V². S. Drzewiecki. *Comptes Rendus,* 187. *pp.* 165–167, *July* 17, 1928.

A short note in which it is shown that the form of the experimental curve (air resistance ÷ square of velocity) is readily explained by a direct application of the elementary kinetic theory to the problem of a plate moving through a gas. H. R. R.

3155. Differential Equations in Dynamics. G. S. Mahajani. *Phil. Mag.* 6. *pp.* 320–323, *Aug.*, 1928.

An attempt to show that the Hamilton-Jacobi equation can be derived from the differential equation of the calculus of variations, and thus further the assertion sometimes made that every differential equation arising from a problem in the calculus of variations with one independent variable can be expressed in Hamilton form. It is then shown that the Hamiltonian system can be obtained directly from Euler's equation of the calculus of variations without the Lagrangian equation being necessary. G. E. B.

3156. Contribution to the Theory of Quaternions. E. Göllnitz. *Akad. Wiss. Wien, Ber.* 137. 2*a. No.* 5–6. *pp.* 351–362, 1928.

See also Abstract 2581 (1928).

3157. Form of the Carbon Atom in Crystal Structure. I. E. Knaggs. *Nature,* 121. *pp.* 616–617, *April* 21, 1928.

Discusses the crystal structure of pentaerythritol tetra-acetate, and takes exception to the space group C_{4h}^3 assigned to it by Gerstäcker, Möller, and Reis, which involves a simple tetragonal lattice. The only possible molecular symmetry is a fourfold alternating axis with a space group C_{4h}^4. E. E. F. d'A.

3158. Dissociation of Liquid Crystals. A. Mlodziejowski. *Zeits. f. phys. Chem.* 135. 3–4. *pp.* 129–146, 1928.

A continuation of the work on liquid crystals of cholesterol and cetyl alcohol [see Abstract 687 (1924)]. The existence of liquid crystals with two dissociation temperatures is established. W. H. Ge.

3159. Structure of Hard Porcelain. O. Krause. *Zeits. f. tech. Phys.* 9. 7. *pp.* 247–263, 1928.

X-ray measurements by the Debye-Scherrer method have shown that when kalolinite is heated the molecule breaks up between 300° and 700°, the macroscopic structure being retained. At 950° mullite,

$3\ Al_2O_3 \cdot 2\ SiO_2$, is formed, but free crystallised Al_2O_3 can also be produced; tridymite can also be formed from the amorphous SiO_2. Mullite is also found in all specimens of porcelain, which can be divided into three groups: those containing much quartz and little mullite, those with mean quartz and mullite content, those with little or no smattered quartz and much mullite. The amount of mullite depends on the amount of kaolin used. Tridymite and cristobalite also occur in porcelain, particularly in those specimens with much quartz. An investigation of the firing process showed that mullite commenced to be formed at 1025°; contraction took place when the structure of the kaolinite broke up; transformation products of quartz were formed above 1000°, which may come from the free quartz or from the SiO_2 in the kaolin; sintering takes place when the fluid phase begins to be formed. H. N. A.

3160. X-Ray Examination of Molluscan Shells. Part I. J. Tsutsumi. *Kyoto Coll. Sci., Mem.* 11. *pp.* 217–221, *July*, 1928.

X-ray examination of the prismatic layer of *Atrina japonica Reeve* showed that it consisted of micro-crystals of calcite arranged fibrously, the principal axes of the crystals being parallel to the direction perpendicular to the shell surface. W. H. Ge.

3161. Crystal Orientation in the Banded " Supposed Aragonite (Arareishi)." H. Fukushima. *Kyoto Coll. Sci., Mem.* 11. *pp.* 223–227, *July*, 1928.

By means of X-ray analysis it was found that the banded " supposed aragonite " is an aggregate of micro-crystals of calcite, and that most of them are so arranged that their principal axes are perpendicular to the surfaces of the layers in the mineral. W. H. Ge.

3162. X-Ray Studies of Changes in Alloys of Copper and Gold. W. Gorsky. *Zeits. f. Phys.* 50. 1–2. *pp.* 64–81, 1928.

The process of the change of an ordered into a disordered lattice has been studied by heating alloys of copper and gold in equal proportions, at various temperatures for different periods of time, investigating the structure of the products by the Debye method. Below 385°, an incompletely ordered solid solution with a tetragonal lattice is stable. The axis ratio a/c varies from 1·07 at 380° to 1·08 at 300°. Above 385°, the stable state is an incompletely ordered solid solution of cubic lattice with lattice constant $a = 3 \cdot 872$ Å. The interconversion of these lattices at 400° is a slow process. The results are discussed both from the viewpoint of thermodynamics and statistical mechanics. F. J. W.

3163. Mechanical Properties of Brass Crystals. M. Masima and G. Sachs. *Zeits. f. Phys.* 50. 3–4. *pp.* 161–186, 1928.

The monocrystals tested contained about 72 % of Cu; they were prepared by Bridgman's method, and the determination of the orientation was carried out by means of reflections from the etched surfaces and Laue diagrams. There were some structural irregularities, and the orientations were finally corrected by taking into account the lines of slip. In spite of these irregularities the crystals behaved with considerable regularity when stretched, and measurements on different parts of the rods and on crystals which had similar orientations, gave similar curves. The anisotrophy of the elastic constants was surprisingly large both for tension and torsion, the ratio of the modulus of elasticity for different orientations being about 1 : 4; the electric conductivity varied in different directions by ± 1·5 % from the mean value. The observations on the slip lines and the alteration in orientation under stretching led to results similar to those of Elam. Various curves illustrate the behaviour of the rods when stretched. When slipping begins after the elastic limit has been reached the shearing-force in the plane of slip is the same for all orientations, being $1·44 \pm 0·07$ kg./mm.^{2}. The disturbances due to multiple slipping were studied, and also the conditions for the commencement of slip on a second plane of slip. A number of photographs of breaks of the rods under tension are reproduced and studied. H. N. A.

3164. Law of Scattering in a Free Lattice. A. Wintner. *Zeits. f. Phys.* 50. 3–4. *pp.* 295–296, 1928.

Points out errors in the mathematical treatment of the problem in a previous paper [see Abstract 2066 (1928).] H. N. A.

3165. Structure of Thallium. H. Perlitz. *Zeits. f. Phys.* 50. 5–6. *pp.* 433–435, 1928.

Consideration of the sudden change of resistance and of the change of volume when Tl-α presses into Tl-β, and when on melting Tl-β takes the liquid form, leads to the conclusion that Tl-α has the closest hexagonal packing, and that Tl-β has a face-centred cubic structure. J. J. S.

3166. Molecular Forces in Crystal Growth. W. Kossel. *Phys. Zeits.* 29. *pp.* 553–555, *Aug.* 15, 1928. *Abstract.*

The molecular theory of crystal growth starts from the consideration of growth at very slow rate. Johnsen and Spangenberg reduced the rate to a few μ per day; no germs are then formed in rock-salt solution. Neuhaus and Günther turned spheres out of crystals of alums and observed the gradual developments of octahedral, cubic, and rhombic faces, of which the first finally predominated, whilst in sodium chloride the cubic faces prevailed. It is presumed that the arrangement of the atoms in the interior extends up to the crystal surface (Madelung). If the crystal repetition takes place in steps, the total energy U liberated by the building up of a crystal will be $U = Lu$, where L is Loschmidt's number per molecule, and u the energy for each step which repeated gives the whole crystal. These relations are examined with respect to homopolar and heteropolar lattices on the supposition that the attraction between any two atoms will decrease with distance at such a rate that, in a cube, not more than twenty-six neighbour-atoms need be considered. Additions of atoms to a chain, an edge, or a face will give different amounts of energy, because there will be one, two or more neighbours; the rate of growth will differ for different faces. In homopolar crystals the energy will be the larger the greater the number of atoms; for heteropolar crystals the opposite will hold. In the octahedral face of rock-salt the planes of the network cannot form surfaces, for they would alternately have to be wholly positive and wholly negative. H. B.

3167. Cohesion and Intermolecular Repulsion. R. K. Schofield. *Phil. Mag.* 5. *pp.* 1171–1176, *June*, 1928.

It is shown that it is reasonable to give the name " cohesion " to the expression $(dU/dv)_T$, when U is the internal energy, no restriction upon the form taken by the ingoing energy being implied, except that it is not chemical and not translational kinetic. Curves showing the variation of cohesion with volume are given for ether, hydrogen, oxygen, nitrogen, acetone, phosphorus, ethyl chloride, ethyl bromide and ethyl iodide, and for carbon bisulphide; for oxygen, ether and some of the other liquids the cohesion rises to a maximum when the volume is increased, and then diminishes. The variation of cohesion with temperature is considered. The results cannot be reconciled with the view that molecules resemble rigid spheres, but can be explained by means of the complex atomic fields postulated by Young and Rayleigh and investigated mathematically by Lennard-Jones. H. N. A.

3168. Problems of the Brownian Molecular Movement. Frida Stadie. *Ann. d. Physik*, 86. 5. *pp.* 751–797, *July* 28, 1928.

A mathematical dissertation, the main object of which is the calculation of the probable period of sojourn of the particles in a volume with given boundaries. The rotational motion of linear particles is also studied with the object of obtaining an explanation of certain glistening phenomena which have been observed in ultra-microscopic particles [see also Abstracts 1609 (1915) and 260 (1922)]. G. E. A.

3169. Quantum Mechanics of Homopolar Valency Chemistry. F. London. *Zeits. f. Phys.* 50. 1–2. *pp.* 24–51, 1928.

The author makes use of a more precise mathematical method to verify and amplify the results obtained in a previous paper [see Abstract 842 (1928)]; the energy relations of the different modes of reaction are investigated, the secular problem, which contains to a first approximation the energies of reciprocal action for all the possibilities of reaction, being exactly solved for atoms of all complexities. The complicated mathematics is applied to several simple cases, so as to show how the molecular terms are related to those of the atoms. In the first example the reactions between an atom with three electrons and one with a single one are dealt with. The first atom is a more general one than that of lithium, and has not two electrons in the same state (K-electrons). There are four characteristic functions for the first atom and one for the second, and there are four different problems of the 4! = 24th order; the rank of the secular problem is in turn, 4, 8, 8, 4. The secular subdeterminants are given; the matrix elements of these are not calculated out, but the solutions are given with the degree of distortion, single, double or triple in each case. A table shows the relation between the term systems of the different possible molecules and the term systems of the atoms. Deals with double and multiple bonds, and explains why a double bond may be, and often is, weaker than a single one. Takes the case of two atoms of valency two, each with two electrons, to illustrate this, and shows that the O_2 molecule has a single bond. A number of spectroscopic facts are brought into relation with the theory. H. N. A.

3170. Quantum Theory, Chemical Combination and Valency. F. London. *Phys. Zeits.* 29. *pp.* 558–561, *Aug.* 15, 1928. *Abstract.*

Application of the quantum mechanics of Heisinger and Schrödinger to the valency problems especially of homopolar compounds of neutral (not ionised) atoms like H_2, CH_4, etc. Reference is made to papers of London and Heitler [see Abstracts 3046 (1927) and 841 (1928)] and of

Pauling [see Abstracts 1622 (1927) and 2519 (1928)]. The mutual reaction between the electrons of two hydrogen atoms may set up two principal resonance oscillations of slight differing frequency and energy, symmetrical or antisymmetrical, leading at different nuclear distances to either attraction or repulsion. A third atom can only be attracted, according to Pauli, if the two first were not coupled symmetrically. These considerations are not limited to the gaseous state, and indicate how chemical compounds can exist in the three states of aggregation. H. B.

3171. Atomic Weight of Cæsium. T. W. Richards and M. Françon. *Am. Chem. Soc., J.* 50. *pp.* 2162–2166, *Aug.*, 1928.

Pollucite is extracted with diluted hydrochloric acid, the cæsium chloride obtained is converted into cæsium alum, and the alum then reconverted into chloride by precipitation with barium chloride. The alum can easily be freed from other alkali metals by recrystallisation. The atomic weight found, 132·81, is in entire agreement with the accepted value [see Abstract 1088 (1903)]. Aston found in 1921 Cs 133 ± 0·2. Redetermination was desirable owing to the high atomic number of Cs, 55, the probable tight packing, and the departure from the whole number rule. H. B.

3172. Transition Probabilities in the Lithium Atom. B. Trumpy. *Zeits. f. Phys.* 50. 3–4. *pp.* 228–233, 1928.

The transition probabilities are calculated for the transitions $2_2 - 2_1$ and $3_2 - 2_1$ by the method using wave-mechanics developed by Sugiura for sodium [see Abstract 3057 (1927)]. An experimental investigation is to follow. [For Part I see Abstract 260 (1928).] A. C. M.

3173. Polarity of the Molecule of Gaseous Hydrochloric Acid. F. I. G. Rawlins. *Zeits. f. Phys.* 50. 5–6. *pp.* 440–442, 1928.

From the pure rotation spectrum, from the behaviour of the dielectric constant in the magnetic field, and from the failure of changing intensity in the ultra-red of short duration the polarity of gaseous HCl is concluded. The result of various lines of inquiry gives no support to the view that ascribes homopolar structure to this gas. J. J. S.

3174. First Separation of the Isotopes of Chlorine. W. D. Harkins and C. E. Broeker. *Zeits. f. Phys.* 50. 7–8. *pp.* 537–547, 1928.

The paper gives the details of the investigation carried out in 1919 and 1920, the results of which were announced in 1920 by Harkins; the publication of the details was delayed owing to the death of the second author in that year. An increase of 0·055 unit was obtained in about 10 grammes of chlorine by diffusing HCl gas through the walls of clay tubes 12·2 metres long; 1/8000 of the original amount of HCl was left after this process. According to the existing theory of diffusion the increase in atomic weight to be expected under these conditions was 0·089 unit, and the actual increase was 62 % of this. The method used was to compare the densities of equimolar solutions of ordinary and of the isotopic HCl; this could be carried out with an accuracy of 0·001 or 0·002 unit in the increase of atomic weight. H. N. A.

3175. Classification of the Isotopes. Part II. G. Beck. *Zeits. f. Phys.* 50. 7–8. *pp.* 548–554, 1928.

Attempts to draw certain conclusions from the regularities in the relations between the isotopes discussed in Part I [see Abstract 1175 (1928)] as to the structure of their nuclei. Attention is mainly paid to nuclei with atomic weight $4n$, which are regarded as being built up of α-particles, forming an inner nucleus, round which nuclear electrons circulate in a finite number of stable orbits in the immediate neighbourhood. The number of these stable orbits is a function of the number of active charges in the nucleus P. According to the Pauli principle these can be at most two electrons in each orbit, or distinguishing between the two directions of spin, at most one electron, so that the total number of electrons depends on P. When new α-particles are added to the nucleus P increases, and at a certain point a new orbit becomes stable; this corresponds to what happens, as shown in Part I, when starting from Ne 20 α-particles are added one by one to the nucleus, the number of external nuclear electrons remaining the same. When the atomic number 40 is reached, two extra electrons are added and the argon isotope Ar 40 is obtained. This process is repeated again and again, and similar results are observed with isotopes with atomic weights $4n + k$, $k = 1, 2, 3$. In these 1, 2 or 3 protons are supposed to move in orbits round the $4n$ inner nucleus. H. N. A.

3176. Mass Defect and Characteristic Size of Nucleus. L. Strum. *Zeits. f. Phys.* 50. 7–8. *pp.* 555–558, 1928.

As Aston [see Abstract 3103 (1927)] accepts mass O = 16 and therefore H = 1·00778, the difference between atomic mass and a whole number becomes the smaller, the greater the mass defect (packing fraction). Plotting the packing fractions against the atomic numbers, he finds that the light elements fall on a rectangular hyperbola which, however, intersects the abscissa twice and does not fit the heavy elements. The author points out that, if H be taken equal to 1, then the mass defect is directly the difference between a whole number and the atomic mass, and all the elements fall on a straight line. That shows that the mass defect is approximately proportional to the number of protons. From the energy relations he draws conclusions as to the arrangements of protons and electrons, which are applied to the model of Lenz of the helium nucleus: four protons moving on a circle and two electrons. The diameter of the circle would be $1{\cdot}4 \times 10^{-14}$ cm.—that is to say, of an order of magnitude smaller than the distance at which, according to Rutherford [see Abstract 2935 (1927)], the electric and magnetic forces of the nucleus become important. H. B.

3177. Synthesis of Elements out of Positive and Negative Electrons. R. A. Millikan and G. H. Cameron. *Nat. Acad. Sci., Proc.* 14. *pp.* 445–450, *June* 15, 1928.

The study of cosmic rays furnishes some evidence that the more stable and abundant elements are being formed at the present time. The evidence is not merely qualitative, but also quantitative. The absorption coefficients of the three bands of rays observed are 0·35, 0·48, and 0·04 per metre of water respectively. These are the rays that would be generated respectively (1) by the formation in one single atom of helium out of hydrogen, (2) by the formation of oxygen out of hydrogen, and (3) by the formation of silicon out of hydrogen. These elements are very widely disseminated in space. Iron is also abundant, and should give a band with an absorption coefficient 0·021. This band is probably also present, but is not within the resolving power of the method. These atom-building processes are probably going on throughout space, even on the earth. E. E. F. d'A.

3178. Impulse Energy Theorem in Dirac's Quantum Theory of the Electron. H. Tetrode. *Zeits. f. Phys.* 49. 11–12. *pp.* 858–864, 1928.

Starting from Dirac's system of differential equations for the wave functions of an electron in any electromagnetic field, it is shown how a particular non-symmetrical tensor may be formed which it is appropriate to choose as impulse energy tensor. The force on the volume element then takes the form of the classical Lorentz expression and does not contain a term corresponding to a magnetic polarisation of the electron. W. S. S.

3179. General Relativistic Quantum Theory of the Electron. H. Tetrode. *Zeits. f. Phys.* 50. 5–6. *pp.* 336–346, 1928.

The generalisation of Dirac's system of wave equations for the electron in accordance with general relativity theory is arrived at by replacing the conditional equations of Dirac for his α matrices, $\alpha_\mu \alpha_\gamma + \alpha_\gamma \alpha_\mu = 2\,\delta^\gamma_\mu$ ($\delta^\gamma_\mu = 1$ for $\mu = \gamma$ and $= 0$ for $\mu = \gamma$), by the tensor equation $\alpha_\mu \alpha_\gamma + \alpha_\gamma \alpha_\mu = 2 g_{\mu\gamma}$, where $g_{\mu\gamma}$ is the fundamental metric tensor and the α_μ's are now in general functions of space and time. The consequences of the generalisation are worked out, in particular the conservation theorem for the electric charge and the impulse-energy law. [See preceding Abstract.]
W. S. S.

3180. Quantum Theory of the Electron. P. A. M. Dirac. *Phys. Zeits.* 29. *pp.* 561–563, *Aug.* 15, 1928. *Abstract.*

The author discusses the movements of the spinning electron in an electromagnetic field from the standpoints of Pauli [see Abstract 2671 (1927)], Darwin [see Abstract 1844 (1928)], Gordon [see Abstract 1841 (1928)], and Klein [see Abstract 1650 (1927)], referring to his own views [see Abstract 1507 (1928)]. One great difficulty in the present views, possibly akin to the difference between past and future, is that the wave equations are not changed in character when $+e$ is replaced by $-e$, whilst the physical meaning is entirely different. H. B.

3181. Application of the Pauli-Fermi Electron-Gas Theory to Cohesive Forces. J. Frenkel. *Zeits. f. Phys.* 50. 3–4. *pp.* 234–248, 1928.

In a former paper [see Abstract 1972 (1928)] the author showed that the equilibrium condition (energy a minimum) was equivalent to the virial law, and the classical formula for the kinetic energy was used. Here it is shown that the equivalence persists when relativity expressions are substituted for the classical ones. This leads to no modifications in the previous results, since there the application considered was to the conductivity of metals, where the velocities of the electrons are so small. So here it is applied to the Thomas-Fermi theory of the complex atom, which treats of the electrons outside the nucleus as a gravitating sphere of gas [see Abstracts 1276 (1927) and 1502 (1928)]. Further, it is applied to the inner structure of the nucleus of the atom, and lastly to the inner structure of stars. A. C. M.

V.3
192

3182. Virial Hypothesis in Wave Mechanics. B. N. Finkelstein. *Zeits. f. Phys.* 50. 3–4. *pp.* 293–294, 1928.

In this mathematical note a relationship is derived which can be regarded as the wave mechanics analogy of the classical virial hypothesis.
H. H. Ho.

3183. Gravity Constants. C. Somigliana. *Accad. Lincei, Atti,* 7. *pp.* 531–538, *April* 1, 1928.

An expression for the gravity constants at the poles and equator is obtained, involving a knowledge of the semi-major axis and the flattening of the ellipsoid of rotation, together with one value of the gravity constant at any given latitude. The results obtained differ but little from the figures of Helmert. Expressions to determine normal gravity constants are also given for the following conditions: (*a*) involving one constant only of the ellipsoid with two values of gravity corresponding to two arbitrarily selected latitudes, and (*b*) involving three values of gravity corresponding to any three given latitudes. The author considers his results will settle the question as to whether values for gravity should depend or not upon the international ellipsoid. [See also Abstract 2277 (1928).]
W. A. R.

3184. Formula Expressing the Deflection of the Plumb-Line in the Gravity Anomalies and Some Formulæ for the Gravity-Field and the Gravity-Potential Outside the Field. F. A. V. Meinesz. *K. Akad. Amsterdam, Proc.* 31. 3. *pp.* 315–331, 1928.

The formula for the deflection of the plumb-line is obtained by differentiating Stokes' formula along a direction tangential to the geoid and it is useful in connecting the astronomical observations and the determination of gravity. The author then deals with the neglected terms of Stokes' formula and establishes the validity of this formula and of others obtained by differentiating it both to obtain the general shape of the geoid and for the local irregularities. Formulæ are also obtained for the gravity field outside the geoid.
R. S. R.

3185. Unitary Theory of Electrical and Gravitational Fields. L. Infeld. *Zeits. f. Phys.* 50. 1–2. *pp.* 137–152, 1928.

A non-Riemannian world geometry, embracing Maxwell's equations and those of the gravitational field, is developed. The general covariance of Maxwell's equations follows from the theory. [See also Abstract 1513 (1928).]
J. S. G. T.

3186. Five-Dimensional Relativity Theory and the Complex Line Element. E. Reichenbächer. *Zeits. f. Phys.* 50. 5–6. *pp.* 425–432, 1928.

It is shown how it is possible to proceed from a four-fold continuum characterised by a complex line element to a five-dimensional manifold, satisfying certain cylindrical relationships [see Abstract 2833 (1927)]. The four-dimensional orbits of massive and charged particles become the geodetic null lines in the five-dimensional manifold.
J. S. G. T.

3187. Differential Equations of the General Theory of Relativity. H. Handrek. *Zeits. f. Phys.* 50. 5–6. *pp.* 397–418, 1928.

It is shown that the differential equations appropriate to the general theory of relativity must be such that the number of linear independent equations must be equal to the number of unknown functions, and that there must be four non-linear relationships between these equations. If, in addition, these four relationships conform to the laws of conservation, then the field equations can be deduced by means of the principle of variation. J. S. G. T.

3188. Physics of Diagrams. G. v. Gleich. *Zeits. f. Phys.* 50. 9–10. *pp.* 725–740, 1928.

The significance of a transformation of coordinates is discussed, and is applied to the case of the special theory of relativity, and it is then shown that the Lorentz transformation, more especially, is equivalent to an approximation to a theory of planetary aberration or of the Doppler effect. The significance of the transformation in the matter of local time, and an argument against the invariance of the fundamental tensor *ds* of the general theory of relativity are briefly considered. J. S. G. T.

METEOROLOGY AND GEOPHYSICS.

3189. Sunspot Numbers and Annual Rainfall in New Zealand. E. Kidson. *New Zealand J. of Sci.* 10. *pp.* 90–97, *July,* 1928.

The paper deals with the relationship between annual rainfall in New Zealand and Wolfer annual observed sun-spot numbers. A positive correlation is found for practically the whole of the North Island and the northern part of the South Island. In the greater part of the Canterbury and Otago Provinces the correlation is negative. A marked feature of the regions with positive correlation is a sudden decline in rainfall in about the second year after sunspot maximum, with a subsequent recovery. In Otago and Canterbury, however, the effect is reversed. Investigation into the fluctuations of the general circulation which give rise to them is necessary before we can understand the nature of the processes involved in the variations described. AUTHOR.

3190. Circulation of Cold and Warm Air between High and Low Latitudes. F. M. Exner. *Akad. Wiss. Wien, Ber.* 137. 2*a*. *No.* 3–4. *pp.* 189–225, 1928.

For the period January to March, 1910, the daily deviation of temperature from the mean was extracted for 120 stations scattered over the land and sea of the northern hemisphere and the deviations charted. On these charts lines were drawn to indicate deviations of 0, ± 5° and ± 10° C. The largest deviations are found in high latitudes. The movements of these zones of positive and negative anomalies are examined while three periods are discussed in detail. Frequencies are obtained (1) for different latitudes during the 90 days of the occurrence of 1, 2, . . . 7 of these air circulation strips, and (2) for different latitudes of 1 . . . 7 regions of ± 5° C. and ± 10° C. anomalies. The distribution of the frequency of cold currents in the northern hemisphere is then determined by finding the frequency of negative anomalies for 10° squares of latitude and longitude. These are charted to show the most frequent flow of air masses. Theoretical considerations are then employed to explain the production of depressions and anti-cyclones by the interaction of these cold and warm air currents and their different rates of travel. The pressure distribution and boundary surfaces are found, and differences between this theory and that of Bjerknes are considered R. S. R.

3191. Some Regions of Formation of Depressions in the Northern Atlantic. (Miss) L. D. Sawyer. *Meteorolog. Office, Prof. Notes*, 4. *No.* 50. [8 *pp*.], 1928.

For each 10° square of the North Atlantic the number of depressions which formed, deepened or filled up in the two seasons, summer (June–September) and winter (October–May) were obtained for the period December, 1905–November, 1910. These figures indicated a region near Nova Scotia and Newfoundland as the most active and secondary winter maxima near the Davis Strait and between Iceland and Greenland for depressions forming or deepening. Reasons are given for these regions being the most active. R. S. R.

3192. Analysis of Tides. A. T. Doodson. *Roy. Soc., Phil. Trans.* 227. *pp.* 223–279, *May* 14, 1928.

A new method of harmonic analysis applied to tidal observations is described and illustrated by tables. It is a modification and extension of Darwin's method. The rule of least squares is applied, but the coefficients are simplified by approximation. The computation involves less labour, corrections can be applied more readily, and the method is capable of yielding data for tests on the completeness of the analysis, and for purposes of research. W. A. R.

3193. Diurnal Variation of Microseismic Disturbance. J. Lacoste. *Comptes Rendus*, 187. *pp.* 447–449, *Aug.* 27, 1928.

Hourly values of amplitude were extracted for waves which were most regular for the period of five months, a difference of 0·4 micron being found. The curve of diurnal variation of amplitude shows minima at 2 to 3 and 16 hours and maxima at 7 to 8 and 19 hours, and is formed by a fundamental wave and its second and fourth harmonics. Examination of the curves shows that normal microseismic motion follows the variation of pressure, temperature and wind speed. R. S. R.

3194. Injurious Vibrating Action of Road Traffic. H. J. Menges. *Zeits. f. tech. Phys.* 9. 9. *pp.* 311–315, 1928.

The author deals with a series of measurements carried out on a badly metalled road in Frankfurt-on-Main, in which the vibrations produced by various kinds of traffic were considered in regard to the damage caused to buildings. A grouping of different kinds of traffic—horse-drawn and motor—is given, and the effects of different kinds of tyres. Further information is required regarding the effects of elastic fatigue in buildings. [See also Abstract 1527 (1928).] R. S. R.

ASTROPHYSICS.

3195. Sun's Cycle of Activity. H. W. Newton. *Royal Meteorolog. Soc., J.* 54. *pp.* 161–173, *July*, 1928.

The paper reviews the main features which have been established regarding the sunspot period, the polarity of bipolar groups and their progression in latitude during the cycle. Similar facts are considered for faculæ and prominences. The nature of sunspots is examined, and also the theory of V. Bjerknes regarding their production. Finally, the 11-year cycle in terrestrial magnetic phenomena and its possible cause are reviewed, and the connection between sunspots and magnetic storms R. S. R.

3196. Calibration of Rowland's Scale of Intensities for Solar Lines. H. N. Russell, W. S. Adams, Charlotte E. Moore. *Mt. Wilson Observat., Contrib. No.* 358. *Astrophys. J.* 68. *pp.* 1–8, *July*, 1928.

The relative intensities in multiplets are expressed by formulæ, based on the correspondence principle, which involve only the quantum numbers of the lines. Although approximate, these formulæ can probably be depended on to give correct average results. Since these theoretical intensities may be assumed to be proportional to the numbers of active atoms producing the lines, the way is open to a calibration of Rowland's scale in terms of N (number of active atoms). Data on 228 multiplets gave a provisional relation between log N and R which was found to depend on wave-length. Correction by successive approximations gave finally $\log N = B \log A$, where A is a function of R, and B a function of λ. The formula is generally applicable to all the elements studied, but uncertainty in the zero point restricts its use to neighbouring lines; even for such lines it gives only relative values of N. The outstanding discordances would be wholly accounted for by a probable error in Rowland's intensities of $\pm 0{\cdot}64$ unit of his own scale. AUTHORS.

3197. New Method for the Analysis of Stellar Spectra. W. S. Adams and H. N. Russell. *Mt. Wilson Observat., Contrib. No.* 359. *Astrophys. J.* 68. *pp.* 9–36, *July*, 1928.

The calibration of Rowland's intensity scale [see preceding Abstract] leads to a knowledge of the relative numbers of atoms in the solar atmosphere which are active in producing different lines in the same spectral region. By assuming thermodynamic equilibrium and that atoms at different levels are equally effective in producing a line, the investigation can be extended to stellar atmospheres in general. The resulting equation (11) connects the relative numbers of atoms producing the same line in different stars with the relative numbers of normal neutral atoms, the excitation potential, the state of ionisation, and the electron pressures and the temperatures of the stars. The application of this relation to high-dispersion spectrograms of typical representatives of the spectral sequence, taken with the coudé spectrograph of the 100-in. reflector, leads to the following provisional results. There appears to be a serious departure from the condition of thermodynamic equilibrium in stellar atmospheres, in that the relative numbers of atoms in excited states, especially those of high energy, are much greater than indicated by theory. The abnormal intensity of the hydrogen lines appears to be a consequence of the phenomenon. The anomaly does not appear to affect ionisation, at least not to the extent that it does excitation. Correction for it leads to a new method of determining stellar temperatures, which gives results agreeing closely with the accepted scale. The behaviour of enhanced lines of iron, titanium, etc., in red giant stars suggests that these lines are produced largely in extensive chromospheres, supported by radiation pressure. The amount of metallic vapour above a given area of the photosphere varies from something like a hundred times that in the sun (Betelgeuse, Antares) to something less than that in the sun (Sirius), a result in fair agreement with the accepted theory which attributes the photosphere to general opacity in atmospheres of similar constitution. AUTHORS.

3198. Predicted Lines of CrII in the Spectra of the Sun and of α Persei. T. Dunham, Jr., Charlotte E. Moore. *Mt. Wilson Observat., Contrib. No.* 360. *Astrophys. J.* 68. *pp.* 37–41, *July*, 1928.

A study of the multiplets in the CrII spectrum, as derived from unpublished terms communicated by C. C. Kiess, indicates that many of the lines to be expected on the basis of theory have not yet been observed in the laboratory. The theoretical positions of these lines have been calculated, and a search for them has been made in the spectra of the sun and of α Persei. As a result, 33 lines in the solar spectrum which were previously unidentified have been assigned to Cr^+; 19 less certain identifications have been indicated as Cr^+?. The best agreement is in the ultraviolet. Further, 33 predicted lines of CrII have been identified in the spectrum of α Persei. When the stellar line is a blend, as is often the case, the contribution of CrII has been estimated by taking account of the stellar intensity, wave-length, and all other possible identifications. In the green, several stellar lines of moderate intensity appear to be almost unblended and due primarily to predicted CrII. In making the identifications of CrII each multiplet has been considered as a whole, attention being given to the theoretical intensities of the individual lines. AUTHORS.

3199. Presence of the Rare-Earth Elements in the Sun. C. E. St. John, Charlotte E. Moore. *Mt. Wilson Observat., Contrib. No.* 364. *Astrophys. J.* 68. *pp.* 93–108, *July*, 1928.

These elements are at low level and ionised in the sun's atmosphere. For ionised atoms their spectra are unique in that the lines are often stronger in the arc than in the spark, and in the flash spectrum show marked differences from the lines arising from neutral atoms and from the ionised states of other elements. They should be useful aids in important lines of astrophysical work. The accurate determination of the wave-lengths of their spectral lines and the study of their relative intensities and appearance under varied conditions of excitation offer opportunities for laboratory investigations of much interest and importance. Ten elements, in the ionised state, La, Ce, Pr, Nd, Sa, Eu, Gd, Dy, Er, and Yb, are shown as present with varying degrees of probability. For five, Il, Tb, Ho, Tu, and Lu, the data are inadequate either to indicate a fair probability of their presence in the sun or to eliminate them from further consideration. AUTHORS.

3200. Photometric Study of the Grey Light from the Moon. A. Danjon. *Comptes Rendus*, 187. *pp.* 336–338, *Aug.* 6, 1928.

The author considers that Arago's method gives better results than other methods. He concludes that (1) if variations of the grey light with time declination of the moon and meteorological conditions exist, they will not be separable from errors of measurements—the grey light of morning and night are the same; (2) for phase angles, a, between 20° and 130°, Russell's expression for the magnitude of the grey light is of the form $\mu = -2\cdot57 + 0\cdot0227\,a$; (3) for the earth at a distance unity the usual magnitude, $M = -3\cdot79 + 0\cdot0227\,a$; (4) the visual albedo of the earth $= 0\cdot29$, where Russell gave $0\cdot45$; and (5) the colour index obtained from selective screens gives $i = +0\cdot07$. The earth is more white than other planets, and has a photographic albedo of $0\cdot56$. R. S. R.

3201. Lunar Photography. H. G. Tomkins. *Phot. J.* 29. *pp.* 346–350; *Disc.*, 350–351, *Aug.*, 1928.

Describes the method developed by the author for obtaining records of the moon, which would show whether or not changes occurred. The details of a special type of reflecting telescope, using a 24-in. main speculum mirror, are outlined. Conditions affecting exposure and the means of overcoming them are also described. Regarding the actual photographic aspect of the question, plates, developers, positives and screening receive consideration. In the *Discussion*, **S. Read** suggests photographing small areas of the moon and then magnifying them up to an ultimate magnification of 2000, for ease in spotting changes. R. C. F.

3202. Photographs of Venus. F. E. Ross. *Mt. Wilson Observat., Contrib. No.* 363. *Astrophys. J.* 68. *pp.* 57–92, *July*, 1928.

Plates taken on 25 nights between June 5 and July 27, at the 1927 east elongation, in ultra-violet, blue-violet, blue, red and infra-red are given. Nothing is seen on the red plates, but faint and strong detail are seen on the blue and the ultra-violet respectively, contrary to expectation. It is inferred that the Venus effective surface is of uniform yellow or reddish structure with small atmospheric mass above it, forming a fogging background which blots out for the red or infra-red photographs any delicate detail in front of it, such detail being only seen on the blue and ultra-violet photographs, whose wave-lengths do not penetrate the fog. Since for Venus the atmospheric mass is, in reality, large, this effective surface must be the upper layer of a shell of yellow dust (say, 10 miles above the actual surface) extending into the isothermal layer of Venus. Spectroscopic evidence indicates a rotation exceeding 15 days, and the author adopts a period of 30 days. All markings, visual or photographic, dark or bright, are cloud undergoing rapid change, and evidence for rotation from these are insecure. He discusses (1) the dark bands, and the bright spots at the terminator cusps and in relation to the problems of rotation and of position of the axis; (2) errors connected with the diameter in different wave-lengths, adopting the value 17·00, corresponding to 7651 miles and a corresponding mean density of 0·919 that of the earth. Microphotometer density curves indicate that the cloud layer upper surface is uniformly billowy. A. S. D. M.

3203. Proper Motions of 217 Southern M Stars. Priscilla Fairfield. *Harvard Coll. Obs., Circ. No.* 322. *pp.* 1–10, 1928.

A discussion of the distribution of proper motions among faint M stars, to see if " intermediate " stars exist filling up the gap between M giants and M dwarfs, as concluded by van Rhijn, since such stars of intermediate absolute magnitude might escape detection because giants are conspicuous from their brightness, dwarfs from their large proper motions. The plates, time-interval, measuring machine, the errors due to measuring of the plates, and of the dispersion in proper motion of comparison stars are discussed. A table is given of the stars. Only one star having large proper motion was found, though more dwarfs might have been expected. All the other M stars are giants, and there is no evidence of any " intermediates " [see following Abstract], though among stars of average 9·6 photometric magnitude, like these, there should be, according to van Rhijn's frequency curve, a sufficient number to make their presence felt. A. S. D. M.

3204. Evolution of Stars with Mass Reduction. C. Lönnqvist. *Arkiv. f. Mat. Astron. och Fysik, Stockholm*, 20. *No.* 21. *pp.* 1–104, 1927.

A theoretical investigation on the basis of Eddington's theory of radiative equilibrium. The author modifies the Russell-Diagram and finds a *real* cleft between M giants and dwarfs [see preceding Abstract]; dissimilar luminosities for giants (at least K to M); narrower limits in energy-store than in masses of stars; a tendency in stars to collect along a velocity evolution line; in giant binaries, both components cannot lose energy through mass transformation alone, nor by this together with contraction. He discusses three hypotheses of energy liberation and adopts the "hydrogen hypothesis" in which protons unprotected against collision are ionised hydrogen nuclei, admitting a process which allows the star to control free proton production velocity with slight change of temperature. As the star develops with continued mass-reduction, its hydrogen percentage becomes more insignificant, and if its atomic disintegration stops it contracts into a white dwarf. He discusses evidence from star clusters and double stars bearing on this. A. S. D. M.

3205. Distribution Function in Spherical Star Clusters. U. Wegner. *Zeits. f. Phys.* 49. 5–6. *pp.* 386–394, 1928.

It is proved mathematically that, assuming a distribution of the Charlier A-type, the distribution of the stars in spherical star clusters is a normal Charlier one. H. N. A.

3206. Orbits of the Spectroscopic Binaries Σ 674A and Σ 1561B. R. F. Sanford. *Mt. Wilson Observat., Contrib. No.* 361. *Astrophys. J.* 68. *pp.* 42–50, *July*, 1928.

The binaries Σ 674A and Σ 1561B are components of Struve double stars which have proved to be spectroscopic binaries. The absolute magnitudes involved in the visual components are quite normal for their types. Σ 1561 has the fairly large annual proper motion, 0″·583. The components of Σ 674A are so nearly alike in magnitude and spectral class that the lines of both appear on its spectrograms. Circular orbits satisfy the radial velocities from the thirty-six spectrograms which have been obtained. The elements are: period, 3·4347 days; systemic velocity, – 27·4 km./sec.; semi-amplitudes of velocity variation, 95·8 and 101·3 km./sec. for primary and secondary respectively. It follows that $m_1 \sin^3 i = 1\cdot4038 \odot$ and $m_2 \sin^3 i = 1\cdot3276 \odot$. The agreement of the differences in the absolute and apparent magnitudes of A and B and the difference in their radial velocities suggests a physical connection of the two stars. There is, however, no certain change in position angle and distance since 1828. Σ 1561B is a dwarf spectroscopic binary showing but one spectrum. Twenty-three radial velocities give an orbit for which the period is 23·5415 days; the systemic velocity, – 13·8 km./sec.; the semi-amplitude of velocity variation for the primary, – 25·8 km./sec.; eccentricity, 0·35; angle of periastron, 0°·00; and time of periastron passage, J.D. 2424303·000 G.M.T. The rather large eccentricity and the small semi-amplitude of velocity variation are noteworthy. The mean radial velocity of Σ 1561A from seventeen spectrograms is – 18·2 km./sec. as compared to – 13·8 km./sec. for Σ 1561B. This is probably close to its true velocity. The range in the individual velocities suggests, however, that A itself may be a spectroscopic binary. The radial velocities of A and B are consistent with motion in their visual orbits. The absolute magnitude, radial velocity, and proper motion of the tenth-magnitude companion to Σ 1561AB indicate that it is not a part of the system AB.

AUTHOR.

LIGHT.

3207. Three Optical Illusions. W. Burstyn. *Zeits. f. tech. Phys.* 9. 9. *pp.* 349–350, 1928.

(1) A sheet of metal has vertical slits cut into it, and behind it a strip on which spokes or circles are marked, is made to move across the slits. If only the lower half of the circles is visible through the slits these circles or spokes appear to rotate. (2) When a light is viewed through a coloured lantern its brightness compared with its surroundings depends upon the intensity of the light. This effect is explained by the differences of the excitation of the eye and the relative intensity of various colours. (3) On a clear moonless night the light from a starry sky appears to be less than that from a white or brightly coloured part of the earth's surface. The effect is most noticeable in southern latitudes and on high mountains. An explanation is given. R. S. R.

3208. Ultra-Violet Transmission of Inorganic Compounds. M. Kimura and M. Takewaki. *Inst. Phys. and Chem. Research, Tokyo, Sci. Papers,* 9. *pp.* 57–64, *July* 25, 1928.

The compounds were examined in a state of fine powder, and were enclosed between quartz plates so as to form a wedge along the length of the slit of a quartz spectrograph. An exposure of 40 min. was given. The colourless compounds of alkali and alkaline earth metals are more transparent than compounds of other elements. In the case of halogen compounds, an increase of the atomic weight of the halogen increases the opacity. The results are expressed by diagrams. F. S.

3209. Geometrical Optics on the Drawing Board. H. Schulz. *Zeits. f. tech. Phys.* 9. 9. *pp.* 343–349, 1928.

The author shows how with the help of a simple known construction it is possible to trace the path of any ray through a lens system. The errors due to chromatic and spherical aberration show at once by this method, the magnitude of the errors can be determined, and the suitability of the system for any particular purpose can be established. The results obtained are discussed in a few cases. R. S. R.

3210. General Cosine Law. H. Boegehold and M. Herzberger. *Zeits. f. Phys.* 50. 3–4. *pp.* 187–194, 1928.

The cosine law for the uniform illumination of very short lines has formerly been expressed only for cases where the illumination was sharp or where the reverse caustics arise one from the other by parallel displacement. The authors express and prove the case for any caustics which lie congruently for one another. Some specially important cases are also considered. R. S. R.

3211. Optical Representation of Non-Self-Illuminated Objects. H. Siedentopf. *Zeits. f. Phys.* 50. 5–6. *pp.* 297–309, 1928.

Using Amphipleura and Gonokokken, a new explanation for the optical dark-ground experiments is suggested, and it is shown that the conclusions drawn from experiments which contradict the Abbes theory are erroneous. The Abbes theory is the only one which is correct for non-self-illuminated images, whilst a spreading beam of light does not restrict delineation as does self-illumination. The difference between these two types of illumination, as suggested by Abbes, is shown to be correct, and is further supported by an optical differential law which is obtained when an objective of limited aperture is used. R. C. F.

3212. Decomposition of Faraday Effects into Two Phenomena of Different Origin: Diamagnetic and Paramagnetic Rotatory Polarisation. J. Becquerel and W. J. de Haas. *Comptes Rendus*, 186. *pp.* 1720–1722, *June* 18, 1928.

The results of decisive tests regarding the existence of paramagnetic rotatory polarisation are described. A thin crystal of tysonite was placed in liquid helium with its optic axis parallel to the field between the poles of a powerful electromagnet. A relation was found spectroscopically between rotation and field strength for different temperatures and wave-lengths. The rotation was found to be proportional to the thickness of the crystal, but not to the field, and it increases as the temperature falls. It is expressed as $\rho = \rho_\infty$ hyper. tan AH, where $A = \Sigma_\infty/RT$ and Σ_∞ is the product of the elementary moment and the Avogadro number. For a given wave-length ρ_∞ decreases as the temperature falls, indicating a decrease of absorption by active bands. This result explains why ρ does not follow exactly the Curie law for small values of H/T. On the contrary, the magnetisation, the primary cause of the phenomenon, obeys this law so long as the hyperbolic tangent can be superposed on the tangent at the origin. R. S. R.

3213. New Photographic Sensitometer. G. Sladbei. *Comptes Rendus*, 186. *pp.* 1612–1613, *June* 11, 1928.

A photographic sensitometer capable of accurately controlling the homogeneity of photographic emulsions was devised. The photographic plate to be measured is rotated on a specially designed rotor which allows of a translation movement. Light from a source is focussed on to the plate by a short-focus lens. From the continuous curve on the plate the density can be measured by a micro-photometer, and the characteristics of the emulsion can be calculated. The method is capable of use for rapid measurements, and can serve for control work. F. J. B.

3214. Mechanical Developing Appliance for Sensitometric Work. O. Bloch and H. Horton. *Phot. J.* 68. *pp.* 352–353; *Disc.*, 353, *Aug.*, 1928.

Mechanical developing is a means whereby certainty and regularity of results are ensured with the minimum of supervision. The authors describe an apparatus which consists essentially of a dish which is irregularly rocked by means of an electric motor. The motor is also utilised for driving a brush backwards and forwards across the surface of the plate being developed. A comparison of plates developed by the hand-brushing method, by the machine without the brush and by the complete machine, shows that the machine and brush give the best results, whilst development with machine rocking only is the most uneven. R. C. F.

3215. Reversal of the Discharge Figures on Photographic Plates. U. Yoshida and J. Tsutsumi. *Kyoto Coll. Sci., Mem.* 11. *pp.* 267–270, *July*, 1928.

An investigation was made of the peculiar reversal of the discharge figures on photographic plates which is caused by fogging the plate with a spark light simultaneously with the impression of the discharge figures. Though the experiments made do not completely explain the phenomenon, they make it a little clearer. It was found that the wave-length of the fogging light which was effective is shorter than about 420 $\mu\mu$. The reversal is not due to a simultaneous illumination of the photographic plates with two lights of short duration. J. J. S.

3216. Theory of the Extinction of Photoluminescence in Solutions of Uranium Salts. S. J. Wawilow. *Zeits. f. Phys.* 50. 1–2. *pp.* 52–57, 1928.

Refers to a paper by Lewschin and the author in which investigations on the extinction of the phosphoresence of these solutions on heating or increasing the concentration are described. The diminution of the luminosity was explained by the effects of collisions of the second kind between the excited molecules and the other molecules of the uranium salt. When there are no such collisions which bring the excited molecules back to the fundamental state without the emission of light, each excited molecule will give out light when it returns to the fundamental state. The author in the present paper shows how the mean time between the excitation of a molecule and the first collision with another dissolved molecule can be estimated, the viscosity of the solvent being taken into account. The molecules are supposed to be subject to Brownian movements. The more complete theory of Leontowitsch [see following Abstract] is referred to. Divergences between the results of the author's theory and the experimental results, with H_2SO_4 as the solvent, are ascribed to the fact that the uranium salt molecules attract a certain number of H_2SO_4 molecules, forming a complex with increased radius. H. N. A.

3217. Theory of Extinguishing Collisions between Molecules Dissolved in Viscous Liquids. M. Leontowitsch. *Zeits. f. Phys.* 50. 1–2. *pp.* 58–63, 1928.

Obtains a formula for the mean time between the excitation of a molecule which has been irradiated and the first collision with another dissolved molecule. The problem is treated as one of diffusion, the theory of Brownian motion being applied. The mathematical method employed makes it possible also to find the mean time T between two collisions, which is different from *t*. The value of T obtained agrees, except for an unessential numerical factor, with the corresponding value of the kinetic theory of gases. The calculated number of collisions with the wall of the containing vessel also agrees with that of the kinetic theory of gases. The results correspond with those of the theory of osmotic pressure and with the van't Hoff equation. H. N. A.

3218. Luminescence Accompanying the Recombination of Halogens. V. Kondratjew and A. Leipunsky. *Zeits. f. Phys.* 50. 5–6. *pp.* 366–371, 1928.

The light emitted by chlorine, bromine and iodine, when heated to temperatures in the neighbourhood of 1000° C., has been examined spectroscopically. It is found that the wave-lengths emitted correspond with those of the continuous absorption region of the halogens. Dymond [see Abstract 523 (1926)] supposes that the continuous absorption is due to the dissociation of molecules into a normal and an excited atom. It is therefore suggested that the continuous emission spectrum is due to the reversal of the photochemical dissociation process, and corresponds with the transformation: $X + X^1 = X_2 + h\nu$. F. J. W.

3219. Decay of Air Afterglow. Maria Majewska. *Zeits. f. Phys.* 50. 5–6. *pp.* 372–384, 1928.

The decay of the afterglow in air has been studied by measuring the intensity of the glow at varying distances from the discharge tube. It is found that the decay process is exponential in character over the range of discharge-tube currents (5 to 30 milliamperes) used. The intensity of the glow is markedly greater when the air is streaming through the discharge tube than when steady. In both cases, however, the decay is exponential. If it is assumed that the decay is due to the deactivation of activated molecules or atoms according to a unimolecular law, the observed results can be explained. F. J. W.

3220. Spark Spectra of Sulphur, Selenium and Tellurium in the Schumann Region. P. Lacroute. *J. de Physique et le Radium,* 9. *pp.* 180–184, *May,* 1928.

The spark spectra have been photographed with a vacuum grating spectrograph between 1235 and 2200 Å. The light was produced by discharge without electrodes in various vapours; a fluorite window separated the discharge tube from the slit and grating, and protected them from the vapours in the discharge space. The results are given in tables, with the wave-lengths and intensities. A large number of lines not previously recorded were observed for each of the above elements. H. N. A.

3221. Fine-Quantum Analysis of Thallium I Lines. M. Kimura. *Inst. Phys. and Chem. Research, Tokyo, Sci. Papers,* 9. *pp.* 51–56, *July* 25, 1928.

Wave-lengths of satellites of complex thallium lines in the ultra-violet region have been recently published by Mohammad and Mathur [see Abstract 2386 (1928)]. Their results are analysed in a different way, employing fine-quantum numbers, which are able to account for missing components on the basis of a selection principle $\Delta f = \pm 1$, or 0 (0 to 0 excluded). A. C. M.

3222. Interferometer Measurements of Wave-Lengths in the Vacuum Arc Spectra of Titanium and Other Elements. C. C. Kiess. *Bureau of Standards, Research J.* 1. *pp.* 75–90, *July,* 1928.

Wave-length determinations by means of the Fabry-Perot interferometer have been made for the vacuum arc spectrum of titanium. More than 300 lines have been measured between 6743 Å. in the red and 2941 Å. in the ultra-violet. For many of the lines the accuracy of measurement exceeds 1 part in 6,000,000; for the majority it exceeds 1 part in 4,500,000. Using only the wave numbers of lines of wave-lengths longer than 4700 Å., and constant wave-number differences as determined in various parts of the spectrum, terms have been derived which have been used to calculate the wave-lengths of the blue and violet lines. The comparison of calculated with observed wave-lengths indicates that no difference in scale exists between the red and violet regions. In addition to titanium, some wave-lengths were measured for iron, copper, calcium, barium, and other elements. AUTHOR.

3223. Change of Colour of Crystals at Low Temperature. I. Obreimow and W. J. de Haas. *K. Akad. Amsterdam, Proc.* 31–3. *pp.* 353–356, 1928.

The change in colour of crystals of azobenzol, potassium bichromate, and iodine in cooling from the temperature of liquid air to that of liquid hydrogen is described. The absorption spectrum consists of lines at the lower temperature, but these have not been classified, and the experiments are to be continued. F. S.

3224. Light Absorption by Layers of Silver Bromide and Silver Chloride. J. Eggert and R. Schmidt. *Zeits. f. Phys.* 48. 7–8. *pp.* 541–544, 1928.

The absorption spectra of thin layers of micro-crystalline silver bromide and silver chloride are investigated by a photographic method, using very little light. The long-wave absorption limit for micro-crystalline silver bromide is found to be at $\lambda = 480\ m\mu$, and for silver chloride at $\lambda = 400\ m\mu$. [See also Abstract 97 (1928).]

3225. Structure and Activation of the Formaldehyde Molecule. V. Henri and S. A. Schou. *Zeits. f. Phys.* 49. 11–12. *pp.* 774–826, 1928.

The ultra-violet absorption spectrum of formaldehyde vapour consists of 35 to 40 bands between 3700 and 2500 Å.U., with a maximum about 2935 like other aldehydes. They are classified into eleven groups: the first seven have fine-structure corresponding to the rotation of the molecule, while the rest are continuous and are due to the predissociated molecule. The fine-structure is really double, and is brought about by two different moments of inertia of the molecule J and K; J is about the symmetry axis C–O (*i.e.*, considering the molecule as a letter Y, with O at the foot, C at the fork, and the two H's at the tops of the arms), and is $1{,}38 \cdot 10^{-40}$, while K is about the axis perpendicular to this and is in the plane of the figure, its numerical value being $23 \cdot 10^{-40}$. These values allow the calculation of the distances between the atoms forming the Y. They are H–H $1{,}38 \cdot 10^{-8}$, H–C $1{,}3 \cdot 10^{-8}$, and C–O $1{,}09 \cdot 10^{-8}$ cm. The successive band-groups correspond to successive vibrational states of the molecule. The band formula involves two vibrational frequencies, $\alpha = 1572{,}3$ and $\beta = 441$ cm.$^{-1}$. The α-period belongs to the C–C vibration and the β-period to the H–H vibration. In the excited molecule the vibration numbers decrease while the moments of inertia increase, so that the atomic distances must increase. The bands are triplet bands, and are compared with the CO bands [see also Abstract 2126 (1928)]; the separations in the bands of both molecules are approximately the same. The formaldehyde molecule is quadrivalent, and the normal state is ^{3}P. Solutions of formaldehyde in water are completely hydrated, but a solution of the vapour in hexane at − 70° is monomolecular, giving bands (without fine-structure) approximately in the positions of the vapour bands. The phenomenon of pre-dissociation (vibrational states quantised and not rotational—a first step towards dissociation) is considered generally; for formaldehyde, in common with other molecules, pre-dissociation sets in earlier when the temperature is raised. A. C. M.

3226. Short-Wave Infra-Red Absorption of Artificial and Natural Sylvine. C. Schaefer and C. Bormuth. *Zeits. f. Phys.* 50. 5–6. *pp.* 363–365, 1928.

It is shown that the absorption bands at $3 \cdot 23\,\mu$ and $7 \cdot 23\,\mu$ given by natural sylvine are not obtained with the artificial product. The bands are not, therefore, harmonics of " Reststrahlen " frequencies, as Reinkober suggests, but are due to the presence of an impurity, which is probably ammonium chloride. F. J. W.

3227. Absorption of the Mercury Line 1941·5 Å. in the Positive Column and Determination of the Optical Concentration of Mercury Ions. W. de Groot. *Zeits. f. Phys.* 50. 7–8. *pp.* 559–569, 1928.

The experiments described in this paper are a continuation of earlier work (Groot and Blok, *Physica*, 7. 315, 1927). The paper gives a description of the construction of the special discharge tube employed and of the method of making the observations, together with a photograph of the spectrum of the source of the light, of the spectrum due to the tube, and the combined spectrum due to the two together. The intensities were compared with the help of wire screens. A curve is given showing the relation between the current in the tube and the value of log I_0/I. From this the author deduces that the number of ions per cubic centimetre lies between $1 \cdot 6 \times 10^{10}$ and $3 \cdot 2 \times 10^{10}$. T. B.

3228. Negative Band Spectrum of Nitrogen. L. S. Ornstein and W. R. van Wijk. *Zeits. f. Phys.* 49. 5–6. *pp.* 315–322, 1928.

The intensities are measured in the negative nitrogen bands 3914, 4278, 3884, and 4237 Å.U. The intensity ratio of the odd to the even terms was 2 : 1. It is shown that the intensity distribution in the bands can be expressed in terms of a Boltzmann function. The doublet intervals are measured and their variation with the order number of the line is shown to be linear, as is required by Hund's theory. A. C. M.

3229. Bands of the Third Positive Group of the Nitrogen Spectrum. R. Schmid. *Zeits. f. Phys.* 49. 5–6. *pp.* 428–462, 1928.

The spectrum of one of the NO bands was obtained by a quartz spectrograph using a discharge in a quartz tube at low pressure, and the wavelengths were determined by comparison with the iron spectrum. A wavelength table is given, and series relations are developed. The results are compared with those of Guillery [see Abstract 2896 (1927)]. A. W.

3230. Intensity Distribution in Band Spectra (and especially Nitrogen Bands). G. Herzberg. *Zeits. f. Phys.* 49. 11–12. *pp.* 761–773, 1928.

The parabolic distribution of intensities in a system of bands put forward by Condon [see Abstract 1385 (1927)] is only observable if there is a uniform distribution of molecules amongst the various possible vibrational states in the initial state of the molecule, a condition not generally fulfilled. Consequently it is expected that there would be large deviations from such a distribution, especially if the binding is approximately the same in the initial and final states. But when the negative and positive nitrogen bands are excited by strong excitation (high electron velocities) the Condon distribution is approximately obtained. The author explains this by attributing a greater preponderance of the higher oscillation quanta when the excitation is greater. A. C. M.

3231. Band Spectrum of Water Vapour. Part III. D. Jack. *Roy. Soc., Proc.* 120. *pp.* 222–234, *Aug.* 1, 1928.

The new methods of analysis of band spectra are applied to the water-vapour bands, a simplified form of the notation proposed by Mulliken [see Abstract 908 (1928)] being employed. The water-vapour bands can be interpreted as arising from transitions between ^2S and ^2P levels. The ^2P levels are subject to σ-type doubling (A, B), while the ^2S are probably rotationally single. The most striking feature exhibited by these bands is the presence of a singlet branch for which the combination principle definitely indicates a transition of two units in j_k. It is, therefore, concluded that, although the j selection rule, $\Delta j = \pm 1,0$, probably holds vigorously, the other selection rules (j_k and σ) are only an expression of the most probable transitions and cannot be taken as final. W. S. S.

3232. New Bands in the Spectrum of Iodine Vapour. P. Pringsheim and B. Rosen. *Zeits. f. Phys.* 50. 1–2. *pp.* 1–14, 1928.

A new absorption band system in iodine vapour is observed, but only when the temperature exceeds 500°. The bands extend from 47,901 to 36,190 cm.$^{-1}$., they can be represented by the formula $\nu = 41{,}900 + 70n' - 90n$. In addition, a number of new bands were found in the infra-red. By combining these various bands with those already known, an attempt is made to construct a scheme of electronic terms for the iodine molecule.

A. C. M.

3233. Band Spectrum of Mercury Hydride. E. Hulthén. *Zeits. f. Phys.* 50. 5–6. *pp.* 319–335, 1928.

The spectrum has been photographed, using a light source of great intensity and high dispersion. New bands appear, by means of which knowledge of the $^2P - {}^2S$ system has been enlarged in certain interesting directions. In addition, some bands appear in the region λ3100 to 2900, which are shaded off towards the red, and which from their structure are related to a $^2S - {}^2S$ system. An isolated very weak band of similar structure at λ2700 apparently originates from a still more strongly excited $^2S - {}^2S$ system. The $^2P - {}^2S$ and $^2S - {}^2S$ systems are fully discussed on the basis of Hund's theory of molecular spectra; the term constants, energy of dissociation and disturbances are investigated. H. N. A.

3234. Interpretation of Band Spectra. Part II. R. de L. Kronig. *Zeits. f. Phys.* 50. 5–6. *pp.* 347–362, 1928.

The diatomic molecule is investigated on the basis of wave-mechanics by an approximation method, and the nature of the eigen-functions, the term-values and the occurrence of transitions are dealt with. This leads to an expression for the dependence of the doublet-separation on the rotational quantum numbers, an explanation of the deviation from the formula-value of certain terms, and an explanation of the state of pre-dissociation, including an estimate of the "life" of the pre-dissociated molecule. [For Part I see Abstract 1618 (1928).] A. C. M.

3235. Time Intervals between the Appearance of Spectral Lines in the Spectra of Alkali and Alkaline-Earth Metals. G. L. Locher. *J.O.S.A. and R.S.I.* 17. *pp.* 91–101, *Aug.*, 1928.

Using the method of Beams and others, the time intervals between the appearance in spark discharge spectra of about fifty lines of sodium, lithium, calcium, barium, strontium, magnesium, cadmium, zinc, and nitrogen were measured for the purpose of determining if there were any relation between these times and the nature of the lines or the positions of the

elements emitting them in the periodic table. The time intervals for different lines varied from zero to about 2 × 10^{-8} second. Most of the lines seemed to be emitted at the very beginning of the discharge, before the potential across the spark gap had dropped appreciably. There did not appear to be any definite relation between the time intervals and the nature or origin of the lines. With one exception, the members of multiplets which could be resolved appeared simultaneously. A variation of the time intervals with the amount of inductance in the spark gap circuit was observed, and an explanation of this is given; the times were independent of the other electrical characteristics of the circuits. In a qualitative theory of the beginning of spark discharge spectra, it is suggested that the time of appearance of any line depends not only on the " life " of the excited atoms, during which there is no emission, but also on the minimum current in the discharge required to excite the line with a visible intensity.
AUTHOR.

3236. Series Spectra of Hg-Like Atoms (TlII and PbIII). K. R. Rao, A. L. Narayan and A. S. Rao. *Indian Journ. Phys.* 2. *pp*. 467–476, *July* 31, 1928.

A preliminary report upon the series regularities of TlII and PbIII, the experimental method of separation of the lines having been previously described [see Abstract 643 (1928)]. Tables are given of multiplets and of comparisons with similar spectra, notably HgI. F. S.

3237. Series Spectra of SnIV and InIII. K. R. Rao, A. L. Narayan and A. S. Rao. *Indian Journ. Phys.* 2. *pp*. 477–483, *July* 31, 1928.

Previous results for SnIV [see Abstract 91 (1928)] are compared with Lang's results and revised term values given for which reasons are assigned. Carroll's and Lang's results for InIII are compared with the authors' values and a number of lines classified. F. S.

3238. Time-Lag in the Emission of Spectral Lines Excited in Vacuum. H. Nagaoka and T. Futagami. *Imp. Acad. Tokyo, Proc.* 4. *pp*. 361–363, *July*, 1928. *In English.*

Discusses the successive stages in the excitation of the spectra of aluminium and copper, as revealed by spectrophotographs of a condenser discharge, taken on a rapidly moving film. A classified list is given of copper lines which show time-lag in excitation. Attention is directed to differences between the spectra emitted in air and *in vacuo*. H. R. R.

3239. Stark Effect of Balmer Series. Y. Ishida and S. Hiyama. *Inst. Phys. and Chem. Research, Tokyo, Sci. Papers*, 8. *pp*. 1–14, *July* 20, 1928.

The hydrogen was mixed with 50 % of helium, which permits larger field strength and eliminates the secondary spectrum. Photographs were taken on a small quartz spectrograph and examined with microphotometers. The appearances of the various components are described in detail and the results on both the old and the new theory (*i.e.*, wave mechanics) compared. Account is taken of the second and third order effects as worked out on the old theory by Sommerfeld and Kiuti and on the new theory by Epstein and Doi respectively. On the whole the results support the wave-mechanics theory. F. S.

3240. Inverse Stark Effect. W. Grotrian. *Zeits. f. Phys.* 49. 7–8. *pp.* 541–545, 1928.

In a previous paper [see Abstract 928 (1928)] Ramsauer and the author described an arrangement for examining the inverse Stark effect in the higher terms of the absorption series, and results were quoted for the second, third, and fourth terms of the principal series of potassium. The method is now extended to the second and third terms of the principal series of sodium. The displacement in the violet is as the square of the field. E. E. F. d'A.

3241. Statistical Calculation of the Rydberg Corrections. E. Fermi. *Zeits. f. Phys.* 49. 7–8. *pp.* 550–554, 1928.

Having already shown that the electric potential in the interior of a heavy atom may be determined statistically as a function of the distance from the nucleus, he applies this method to the calculation of the terms of any atom, and particularly the Rydberg corrections of the *s*-terms. The result shows only the general course of the Rydberg corrections as a function of the atomic number, and not how they differ from one atom to another. But the general features are quite faithfully shown.

E. E. F. d'A.

3242. Magneto-Optical Measurement of Potassium Lines. J. Weiler. *Zeits. f. Phys.* 50. 5–6. *pp.* 436–439, 1928.

The measurement of the magneto-rotation in the neighbourhood of the isolated absorption bands gives a method of determining the absolute number of the dispersion electrons. This serves as a measure of the intensity of these lines. The measurements on the two first members of the principal potassium series gave for the ratio of the doublets 2 : 1; for the intensity ratio of the first and second members 96 : 1. Measurements on the red member can be used for the determination of an empirical vapour pressure formula which agrees with the value obtained by other methods. J. J. S.

3243. Broadening of Spectral Lines owing to the Vapour Density of the Absorbing Atoms. E. Vogt. *Zeits. f. Phys.* 50. 5–6. *pp.* 395–396, 1928.

Points out that the measurements of the "coupling broadening" carried out by W. Schütz with pure sodium vapour, and those of Trumpy using the Hg resonance line 2537 with foreign gases at high pressure, have been carried out under the influence of effects of different character. The result is that Trumpy's breadths are from 300 to 600 times as great as those of Schütz for the same number of atoms per c.c. Trumpy's effect, if real, could only be explained by a theory of a combination of the coupling effect and damping by collision. H. N. A.

3244. Structure and Activation of Aromatic Nitriles. Ultra-Violet Spectra of their Vapours. H. Elizabeth Acly. *Zeits. f. Phys. Chem.* 135. 3–4. *pp.* 251–290, *Aug.*, 1928.

The study of benzonitrile and its homologues is based upon the measurement of the absorption spectra, previously investigated by Purvis [see Abstract 518 (1924)] and quantitatively by Scheibe. The vapours of benzonitrile show 178 measurable lines and bands. Ortho- and metatolunitrile give similar absorptions, but the spacings are different; the metabands are further apart than the ortho-bands. The para-spectrum is of entirely different character and the intensities are smaller. Two band regions can be distinguished in all the vapour spectra; the first shows distinct bands, the second only a continuous absorption. The activation potential corresponding to the first region is 4·51 volts for benzonitrile and increases from 4·416 to 4·534 volts in the ortho-, meta-, and para-tolunitriles (and to 5.48 in dicyanogen), whilst there is a decrease in the isomeric dichlorobenzene. The vibration spectra consist of doublets. The first activation energy is smaller for benzonitrile than that for benzene; the activation of a molecule generally requires less energy than that of the constituents according to Henri. As regards the three derivatives, the spectrum of the ortho-compound is furthest shifted towards the red. When the molecules are activated, the distances between the oscillating atoms increase by about 2 %. The moment of inertia of benzonitrile is approximately $J = 38 \cdot 8 \times 10^{-40}$. The molecules of the tolunitriles are predissociated by the first activation, those of the benzonitrile after two activations. H. B.

3245. Duration of Metastable Hg-Atoms. T. Asada, R. Ladenburg and W. Tietze. *Phys. Zeits.* 29. *pp.* 549–550, *Aug.* 1, 1928.

Measurements of the life of metastable Hg-atoms have been made with a rotating disc and are thus free from the objection to previous measurements in which atoms were electrically excited. Excitation is by light from a mercury lamp direct and then through a filter passing 4047 Å. and 4359 Å. The intensity of the 5461 Å. line viewed through a given filter is a measure of the life of $^3P_0$ atoms. When a few mm. of nitrogen are added the life is about 15×10^{-4} sec. F. S.

3246. Measurements on the Absolute Intensity of X-Rays. T. E. Aurén. *K. Vetenskapsakad, Nobelinst., Medd.* 6. *No.* 13. *pp.* 1–24, 1927.

An apparatus was constructed for measuring the absolute intensity of X-rays by the aid of the heat excited in metals by absorption of the rays. Experiments with absorption plates of copper, silver and lead were performed. The results showed that no differences in the energy measurements arise from using absorption plates of different metals. Up to 100 kV the intensity is exactly proportional to the strength of the current through the tube. The total intensity of the energy radiated as X-rays from an antikathode of tungsten was determined at constant and at undulating voltage. In the beginning the intensity increases in each case rather faster than proportionally to the square of the voltage; but from about 69 kV the increase is in exact accordance with this law at constant voltage. With the undulating voltage, the same law is already valid from a somewhat lower voltage than 69 kV. The intensity of the unfiltered radiation expressed in ergs per cm.^{2} per sec. at a distance of one metre from the antikathode and with a current of one milliampere through the tube can be calculated from the following formulæ: constant voltage, $I_c = 0 \cdot 0055\, V^2 - 12 \cdot 7$; undulating voltage, $I_u = 0 \cdot 0041\, V^2 - 2 \cdot 0$. In these formulæ V means the voltage in kilovolts. In the formula for undulating voltage, where not the maximum but the effective voltage was measured, the constants refer to a voltage curve of the shape used in these experiments. The total intensity of the continuous X-ray spectrum filtered through aluminium of the thickness *d* can be calculated from the formula:

$I = I_0 e^{-md^n}$, where I_0 is the intensity of the incident and I that of the transmitted radiation, m and n being constants depending on the voltage and the shape of the voltage curve used. The results of Boos, Grebe and Kriegsmann concerning the transformation of energy in ionisation by X-rays of different wave-lengths are discussed. Control tests of their energy measurements were performed. When the author's energy measurements are taken as a basis for the calculation, the energy necessary to produce a pair of ions shows no increase with decreasing wave-length.

AUTHOR.

3247. Electrified Spherical Films and the Compton Effect. L. Décombe. *Comptes Rendus*, 186. *pp*. 1607–1610, *June* 11, 1928.

It has been shown that a diminution in frequency is produced in a portion of the X-rays which are diffused by passage through material particles. The theory of electrified spherical films, which has been employed in other connections [see Abstracts 541, 1164 and 2131 (1928)], is used to explain the change of frequency. F. J. B.

3248. Fluorescent Secondary X-Radiation and the J-Phenomenon. W. H. Watson. *Phil. Mag*. 5. *pp*. 1145–1163, *June*, 1928.

In experiments with fluorescent radiators a thin sheet of silver or tin was placed in the path of a beam of X-rays just sufficiently penetrating to excite the K-series radiation. The secondary K-series radiation passed into two ionisation chambers, in two different directions from the radiator, and the ratio of the ionisation currents in the two chambers was measured when equal thicknesses of absorbing material, such as aluminium, were placed in the two beams; this ratio did not alter continuously when the thickness x of the absorbing material was increased, but showed discontinuities in its relation with x, which seem to be of the same nature as the J discontinuities previously observed, using the secondary X-radiation from light substances such as paraffin wax. The radiation studied was composed almost entirely of the K characteristic radiation of the radiator.

H. N. A.

3249. Modified Scattered X-Radiation and Superposition. The J-Phenomenon. Part VIII. C. G. Barkla. *Phil. Mag*. 5. *pp*. 1164–1171, *June*, 1928.

Gives a general account of the results previously obtained. The new experiments described show how "unmodified" scattered radiation can be changed to "modified," not only by causing it to pass through a certain critical average frequency, as measured by an average absorption coefficient, but also by means of a change in another governing factor, which, as far as can be seen at present, can only be identified with the large scale structure of the radiation. This change was produced by the superposition of radiations of the same frequencies in almost exactly the same proportions. An unmodified radiation was obtained from air or thin paper, but the degree of modification rapidly developed with increased thickness of the scattering substance, and approached a limiting value. The modification depends on some kind of coherence of the whole radiation, perhaps a certain degree of continuity or of superposition of the whole stream of radiation. H. N. A.

3250. General X-Radiation from Mercury Vapour. W. Duane. *Nat. Acad. Sci., Proc*. 14. *pp*. 450–455, *June* 15, 1928.

The intensity and penetrating power of the radiation produced by the impact of electrons on mercury-vapour atoms has been measured in directions along and perpendicular to the line of motion of the electrons. In neither case was the beam homogeneous. The intensities per mercury atom in both directions are of the same order of magnitude. The theoretical conclusion of Kramers [see Abstract 863 (1924)], that the intensity decreases almost exactly as the universe of the square of the wave-length, is confirmed within the limits of experimental error. [See also Webster and Hennings, Abstract 1871 (1923).] F. J. W.

3251. Polarisation of Characteristic Radiation. J. A. Bearden. *Nat. Acad. Sci., Proc.* 14. *pp.* 539–542, *July*, 1928.

Recent work by Bishop [see Abstract 706 (1927)] indicated the presence of some degree of polarisation in the characteristic X-radiation from a molybdenum antikathode. The present work is carried out both with filtered radiations and with characteristic rays separated out by crystal reflection. The results indicate that the apparent polarisation is associated with the general radiation from the tube, which is only incompletely removed by filtration. The filtered rays give indications of polarisation, less marked than in the experiments of Bishop. Molybdenum $K\alpha_1$ reflected from a calcite crystal, gave a corrected ratio of scattered intensities, perpendicular and parallel respectively to the kathode stream, of 0·993 ±0·004, which is sufficiently near unity to suggest that the radiation is completely unpolarised. [See also next Abstract.] H. R. R.

3252. Spectrum and State of Polarisation of Fluorescent X-Rays. A. H. Compton. *Nat. Acad. Sci., Proc.* 14. *pp.* 549–553, *July*, 1928.

The fluorescent X-ray spectrum of silver, excited by an X-ray tube with tungsten antikathode, operated at 53 kilovolts, is examined by the ionisation spectrometer. Approximately 99 % of the X-ray energy from the silver is found to be in the characteristic K lines, continuous X-radiation being almost entirely absent. [This compares very favourably with filtration or even crystal reflection for the production of a homogeneous beam; filtration of a fluorescent beam from molybdenum (zirconium filter) may give 98 % "homogeneity" ($K\alpha$ doublet), as compared with the 25 % obtainable by filtration of the primary beam.] The corrected ratio of $K\alpha$ to $K\beta$ in the fluorescent beam from silver is found to be 4·5, sufficiently close to Unnewehr's value of 4·65 for primary silver K rays [see Abstract 1192 (1924)]. The fluorescent radiation is found to be not more than 0·5 % polarised, *i.e.*, it is in all probability completely unpolarised. [See also preceding Abstract.] H. R. R.

RADIOACTIVITY.

3253. Ionisation Curve for Pure Hydrogen with Polonium α-Rays. F. Joliot and T. Onoda. *J. de Physique et le Radium*, 9. *pp.* 175–179, *May*, 1928.

The apparatus of Irène Curie was used; the polonium preparation surrounded by a case of thin aluminium to prevent contamination of the hydrogen by polonium could be moved to different distances from the two plates through which the ionisation current passed. The normal Bragg curve in air with polonium α-rays measured by Irène Curie was taken as the curve of reference; a new air curve was constructed with a freshly prepared source and compared with the Curie curve; in this way the quality of the source was determined. Another air curve was constructed with the source enclosed in aluminium to find the effect of this screen. The hydrogen curve was then obtained using different pressures of hydrogen. The range in pure hydrogen at 15° C. and 760 mm. Hg is 17·30 ± 0·03 cm., and the ratio of the stopping power of H_2 as compared with air is 0·223. Numerous determinations give 3·87 ± 0·01 cm. at 15°. C. and 760 mm. Hg for the range in air. H. N. A.

3254. Ionisation Curve of the α-Rays of Polonium in Pure Oxygen. T. Onoda. *J. de Physique et le Radium*, 9. *pp.* 185–186, *June*, 1928.

The ionisation curve is obtained with the apparatus of Irène Curie [see Abstract 2530 (1925)]. The extrapolated range of the polonium α-particle in specially purified oxygen at N.T.P. is given as 3·49 ± 0·01 cm., at 15° C. and normal atmospheric pressure 3·63 ± 0·01 cm. The molecular stopping power of oxygen, relative to air, is given as 1·066 ± 0·01. The distance from the point of maximum ionisation to the end of the extrapolated range is 0·56 cm. H. R. R.

3255. Vaporisation of Polonium. P. Bonèt-Maury. *Comptes Rendus*, 187. *pp.* 115–117, *July* 9, 1928.

Having previously shown that the vaporisation of polonium takes place according to the cosine law, the author describes the determination of the velocity of the evaporation of polonium into vacuum, *i.e.*, the measurement at constant temperature of the quantity vaporised as a function of the time. The apparatus previously used, but somewhat modified, was employed. J. J. S.

3256. Volatilisation Curves for Radium B and Radium C deposited on Gold by Single and Double Recoil. E. Bussecker. *Akad. Wiss. Wien, Ber.* 137. 2*a*. *No.* 1–2. *pp.* 117–126, 1928.

The existing experimental data are insufficient to allow of a satisfactory explanation of variations in the volatilisation temperatures of the active deposits, in terms of the specific properties of the materials, state of chemical combination, material on which they are deposited, pressure and nature of the surrounding gas, etc. The present experiments deal with radium B and C deposited on gold (1) by the usual exposure in an electric field to radium emanation and (2) by the condensation method of Pettersson [see Abstract 1198 (1924)]. In case (1) the deposit is obtained by simple recoil from radium A. In case (2) the radium is driven into the gold by recoil from the condensed emanation, the radium B by a second recoil from radium A. Case (2) is taken to be the more favourable for the formation of possible alloys of the active deposit with gold. The experimental volatilisation curves exhibit slight differences in the two cases, which can be interpreted in this sense. H. R. R.

3257. Radioactivity of Potassium and Rubidium. Marie Kuban. *Akad. Wiss. Wien, Ber.* 137. 2*a*. *No.* 5–6. *pp.* 241–257, 1928.

A detailed investigation of the absorption in aluminium of the rays from K and Rb. The measurements are made photographically (exposures of about three months) and by the ionisation method. Corrections are made for the geometry of the source and for the necessarily thick layers of active material. The results are in opposition to those of Harkins and

Guy [see Abstract 313 (1926)]. Absorption coefficients of 28 cm.$^{-1}$ and 173 cm.$^{-1}$ in aluminium are given for K and Rb respectively. The ratio of the intensities of the radiations is Rb : K = 2·4 : 1. Assuming that the potassium isotope of mass 41 is responsible for the radiations, the half-value period is deduced to be $1\cdot31 \times 10^{10}$ years [see also Holmes and Lawson, Abstract 1774 (1926)]. The work includes an extensive bibliography of papers on the radioactivity of potassium and rubidium.
H. R. R.

3258. Number of Ions produced by α-Rays from RaC′ in Air. Irène Curie and F. Joliot. *Comptes Rendus*, 186. *pp*. 1722–1724, *June* 18, 1928.

An apparatus devised for the measurement of sources of intense α-rays is employed, but only a very small fraction of the total rays from the source is used to produce ionisation. The β-rays are eliminated by deviation in a magnetic field, while the effects of the γ-rays are found by passing them through Al screens and measuring the absorption. The result, experimental details relative to the Bragg curve, and the determination of the number of ions produced by 1 millicurie of RaC′ are to be published later.
R. S. R.

3259. Apparent Evidence of Polarisation in a Beam of β-Rays. R. T. Cox, C. G. McIlwraith and B. Kurrelmeyer. *Nat. Acad. Sci., Proc.* 14. *pp*. 544–549, *July*, 1928.

The new quantum mechanics suggests that a beam of β-particles might exhibit polarisation. The very short equivalent wave-length of a fast β-particle limits the possible methods of attack. Here the problem is investigated by double scattering, with an arrangement geometrically similar to that used by Barkla to show the polarisation of X-rays. Two gold-scatterers are used, and the scattered particles are detected by a Geiger counter with an automatic recording device. The experiments are difficult, and as yet incomplete, but an apparently definite asymmetry in scattering has been recorded, which can be qualitatively explained in terms of the properties of the spinning electron.
H. R. R.

3260. β-Recoil of Thorium B. L. Wertenstein. *Zeits. f. Phys.* 49. 5–6. *p*. 463, 1928.

Donat and Philipp [see Abstract 959 (1928)] have criticised the work of A. Muszkat, and the author points out that, since the velocities in the β-recoil of ThC are not high, it is to be expected that the yield will be lower than in the case of RaC. There was a difference between Miss Muszkat's method and that of Donat and Philipp, as she used only recoil particles moving approximately normal to the emitting surface, while they employed a solid angle of nearly 2π. **Errata,** *ibid.*, 50. 1–2. p. 160, 1928.
H. N. A.

3261. Spectrography of γ-Rays by Means of Crystalline Diffraction. M. Frilley. *Comptes Rendus*, 186. *pp*. 1614–1615, *June* 11, 1928.

A spectrograph for the study of γ-rays by crystalline diffraction was described in previous communications [see Abstracts 1319 and 1320 (1928)]. Further investigation of the extreme limit of this part of the spectrum revealed some very feeble rays, one of which was identical with RaC and having a wave-length of 16 U.X. The characteristics of these new rays were determined.
F. J. B.

HEAT.

3262. Entropy of an Electron Gas from the Standpoint of Fermi's Statistics. A. C. G. Mitchell. *Zeits. f. Phys.* 50. 7–8. *pp.* 570–576, 1928.

This is a mathematical paper in which the molar entropy of a monatomic gas as calculated from the Sackur-Tetrode formula is compared with that calculated from Fermi's theory. The two expressions differ by R . log G, where G is a quantum number and has, as pointed out by Fowler, the value 2. The results on the newer theory differ from those on the older by the occurrence of G, and by the fact that an electron gas under normal conditions behaves as a feebly degenerated gas. A graph between entropy and temperature shows the differences between the results obtained on the two theories. T. B.

3263. Mixed Gases. N. Carrara. *N. Cimento,* 5. *pp.* 224–233, *June,* 1928.

Calculations are given of the final conditions of a mixture of gases which do not act chemically upon each other, the initial conditions of the separate gases being known and the mode of action of the mixture. The gases are supposed perfect and the final conditions of the mixture are compared with those corresponding to the characteristic equation of a perfect gas, and with van der Waals' equation. J. J. S.

3264. Vapour Pressure and Heat of Dilution of Aqueous Solutions. Part V. Activity. E. P. Perman. *Faraday Soc., Trans.* 24. *pp.* 330–336; *Disc.,* 336, *June,* 1928.

Calculation by means of the vapour-pressure results for cane-sugar solutions obtained by Downes and Perman [see Abstract 2098 (1927)] gives for the activity of the water values which show that, at 80°, cane-sugar solutions up to the strength $n : N = 0\cdot04$ may be taken to be perfect solutions, whilst up to $0\cdot07$ the deviation is very small. The fact that the solution is perfect up to a considerable concentration makes it easy to calculate the activity of the solute, which is proportional to $n/(N + n)$ up to about 500 gm. per litre; at greater concentrations the deviation increases and is due probably to the volume of the solute molecules. Similar results are obtained at 70° and 50°, but the lower the temperature, the lower the concentration at which the solution becomes imperfect. Being a non-electrolyte and forming no hydrates, urea should form solutions at least as perfect as those of cane-sugar. The activities calculated from the results of Perman and Lovett [see Abstract 1860 (1926)] show that the solutions are apparently more than perfect. This is probably due to slight hydrolysis of the urea, with formation of traces of ammonia. Allowing for the error thus introduced, urea appears to form a perfect solution up to $n/N = 0\cdot8$ at 80° and up to $0\cdot5$ at 60°. With potassium chloride solutions the activity of the water falls off regularly with increase of concentration in the usual way. The calculation of a_2 is difficult, as the curve connecting N_1/N_2 and a_1/N_1 runs off to infinity. If, however, a_2/N_2 is taken as unity at the dilution $N_1/N_2 = 10{,}000$ instead of infinity, the integration is easy. Calcium chloride solutions are dealt with similarly. The relation between activity (of the water) and heat of dilution is given by the equation

$$H = RT^2 \frac{\partial}{\partial T}(-\log_e a_1),$$

which may be useful in some cases for calculating activities. T. H. P.

3265. Dissociation of Sodium Sulphate Decahydrate. E. P. Perman and W. D. Urry. *Faraday Soc., Trans.* 24. *pp.* 337–343, *June*, 1928.

The dissociation pressure of decahydrated sodium sulphate, measured by a method similar to that used by Downes and Perman [see Abstract 2098 (1927)], is a linear function of the temperature. The maximum work or the free energy change, $A = RT \log_e (\pi_0/\pi_\pi)$, where π_0 is the vapour pressure of ice and π_π the dissociation pressure, varies from 2732 at 0° to 2663 at 32° per 10 mols. of ice. The Kirchhoff relation between the heat of reaction at constant volume and the sum of the molecular heats of the participants and the Clausius-Clapeyron equation give the expression

$$\log_{10} \pi_\pi = \frac{-60974 \cdot 3}{2 \cdot 30259RT} - \frac{163 \cdot 4738 \log_{10} T}{R} + 249 \cdot 4969,$$

where $R = 1 \cdot 9875$ cal. and absolute zero $= 273 \cdot 1$. The observed values for the dissociation pressure agree well with those calculated from this expression, and the relation between $\log \pi_\pi$ and $\frac{1}{T}$ is linear. From the values of π_0 and π_π at 0° and 22·5°, the heat of hydration of the salt by liquid water is calculated to be $Q = 1850$ cal. per mol. of water, the observed value for 11·25° being 1829 cal. The experimental values of the heat of hydration at four temperatures between 20° and 30° C., when plotted against the temperature, lie on a straight line, which very nearly passes through the value calculated from van't Hoff's equation and through Thomsen's value. Application of the Nernst heat theorem to the dissociation of the decahydrate gives for the heat of hydration values in satisfactory agreement with the observed values. The mean value of the chemical constant of water vapour is found to have the mean value 3·63 between 0° and 30° C. T. H. P.

3266. Vapour Pressures of Binary Systems. A. W. Porter. *Faraday Soc., Trans.* 24. *pp.* 343–347, *June, and pp.* 405–408, *July*, 1928.

Part I.—According to the law of Duhem-Margules, if a_1 be written for π_1/Π_1, where π_1 is the vapour pressure of one constituent in equilibrium with the system and Π_1 the value when the second constituent is absent, and similar symbols with suffix 2 denote similar quantities for the second constituent, then

$$\mu_1 \frac{\partial}{\partial \mu_1} \log a_1 = \mu_2 \frac{\partial}{\partial \mu_2} \log a_2,$$

where μ_1 and μ_2 are the molar fractions of the constituents in the binary system each reckoned as of the same molecular type as in the vapour state. The failings of this equation are discussed and it is shown that, in spite of these, there is sufficient flexibility in the choice of the constants to represent any experimental case. The case $\phi = \beta(1 - \mu_1)^2$ has been

31
28

often used, and the present paper deals with cases for which this particular term alone is inadequate. The data for aqueous sucrose solutions are represented satisfactorily by the equation $\phi = 0{\cdot}4 \log \mu_1 - 10\,\mu_2^2$. Raoult's law does not hold here, even in the most dilute region. The case of aqueous potassium chloride solutions at 80° is also considered, as well as the application of the equilibrium vapour pressures to reaction equilibria.

Part II.—The expression $\log (a_1/\mu_1) = \dfrac{\beta\mu_2^2}{(1+\rho\mu_2)^2}$ has been applied to the experimental data for the system gold-mercury, but this is of a form forbidden by Margules' equation and fails to bring out important properties of the mixture. The equation $\log a_1 = \alpha \log \mu_1 + \beta\mu_2^2 + \gamma\mu_2^3(4 - 3\mu_2)$ is of a permissible form and it satisfies the experimental data if $\alpha = 0{\cdot}91$, $\beta = 1{\cdot}998$ and $\gamma = 0{\cdot}78$ (logarithms to base 10 being used). The properties of the curve connecting μ_1 and π_1/Π_1 are considered. T. H. P.

3267. Temperature Radiation. W. E. Forsythe. *J.O.S.A. and R.S.I.* 16. *pp.* 307–328, *May*, 1928.

A concise survey of the subject given in the form of a Presidential Address. E. G.

3268. Thermal Utilisation of the Sun's Radiation. F. Pasteur. *Comptes Rendus*, 187. *pp.* 30–32, *July* 2, 1928.

A small apparatus is described which is in the form of a parabolic searchlight hermetically closed by a special glass. The enclosed reflector is of aluminium, and with the comparatively unfavourable sunlight of Paris, water is made to boil in a small glass tube in one minute and distils 60 gm. of water in an hour. When 140 small thermocouples are placed at the focus a current is obtained sufficient to work eight small triode valves. It is claimed that a similar apparatus could be constructed with a reflector 3 metres in diameter. The results are said to be four or five times better than those obtained in Africa with other forms of apparatus. T. B.

3269. Radiation Fluctuations according to Light Quantum Statistics. R. Fürth. *Zeits. f. Phys.* 50. 5–6. *pp.* 310–318, 1928.

A general discussion of the various means of calculating the radiation fluctuations shows that the formulæ developed by the author [see Abstract 1945 (1928)] are satisfactory, and are used in this paper. Formulæ are developed for the fluctuations of the light quantum number and the radiation energy, not only for a small frequency range, but also for the whole spectrum for any spectral composition of the hollow body radiation. Two special cases are considered, namely, the fluctuation appearances for the Planck type of radiation and particularly Einstein's equations. Finally, the temperature and pressure fluctuations of the radiation are considered. R. C. F.

SOUND.

3270. Measurement of Sound Absorption in a Room. Vera O. Knudsen. *Phil. Mag.* 5. *pp.* 1240–1257, *June*, 1928.

A critical discussion of the various methods used to measure the sound absorption in a room. Some preliminary experimental work is reported in which an electromagnetic cone-type of loud speaker is used as the source and four rotating electromagnetic receivers as the detectors, and the results are compared with those obtained by other methods. W. H. Ge.

3271. Classical Reasonableness of the Quantum Theory and Simple Operative Solutions of Schrödinger's Equation. A. Press. *Phil. Mag.* 6. *pp.* 33–49, *July*, 1928.

Deals with the analogy between the action of a radiating harmonic oscillator and that of a reed or organ pipe, which was suggested in a previous paper [see Abstract 988 (1928)]. It was shown that the amplitude of the radiation wave bears a definite ratio to the amplitude of the normal non-radiating component, and in the present paper reference to the non-radiating component is considered to be sufficient. For the pipe, the excitation field is that due to the blowing stream. There will be a variable velocity potential, P, in this stream because of the vibrations of the pipe; the wave-front of velocity potential travels backwards along the stream. Relationships are found between the velocity of the vibrating reed or slit wall and the mean velocity of the stream, and between the speed of the pulsating wave-front of the velocity potential and the mean stream velocity. From the differential equation of wave-motion the final form of Schrödinger is obtained without the use of the Hamilton varying action principle or the Hamilton-Jacobi equation. The author explains why, in solving Schrödinger's equation for the Balmer series, only the conservative system of the radiator need be considered. Equations of the type used by Schrödinger can be solved by a general operational method analogous to the factoring method employed by Heaviside. H. N. A.

3272. Theory of Struck String. K. C. Kar. *Phil. Mag.* 6. *pp.* 276–280, *Aug.*, 1928.

A theoretical paper criticising the Raman-Banerji theory of the pianoforte string. In this theory values of velocity and acceleration of the struck point of the string were obtained by differentiating term by term a certain non-uniformly convergent series, and they are, therefore, invalid. W. H. Ge.

3273. Struck String. P. Das and S. K. Datta. *Phil. Mag.* 6. *pp.* 479–481, *Sept.*, 1928.

A note in reply to the criticisms of Kar and others [see Abstract 1662 (1928)] who have misunderstood the Das theory of the struck string. Kar and his associates, in adopting the experimental arrangements of George and Beckett, have omitted essential details and, by so doing, have rendered invalid their measurements of the amplitude of the partials by Datta's microscope method. Several other points are noted. W. H. Ge.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS AND ATMOSPHERIC ELECTRICITY.

3274. Dust Electrification. H. Israel. *Zeits. f. tech. Phys.* 9. 8. *pp.* 289–293, 1928.

The theory of Böning on dust electrification [see Abstract 410 (1928)] is discussed, and experiments with numerous substances are described which extend its scope and show that it is applicable, not only to material of one kind, but to different substances when brought into contact with each other. J. J. S.

3275. Measurement of *e/m* with a Three-Electrode Valve with Simultaneous Measurement of its Amplifying Factor. D. S. Kothari. *Indian Journ. Phys.* 2. *pp.* 485–490, *July* 31, 1928.

Greinacher's method for the measurement of e/m has been modified by using a triode in place of the diode. The grid is kept at zero potential and the procedure and calculations are exactly the same as before. As the magnetic field is increased the anode current first remains constant and then suffers a sudden decrease and gradually approaches zero. In order to obtain reasonably accurate values of e/m the value of the magnetic field must be used at which the sudden decrease occurred. This question is discussed in some detail. If the grid is given a potential E_g, the value of e/m is given by $e/m = 8\cdot 10^8(E_p + \mu E_g)/b^2H^2$, where μ is the amplification factor. Assuming e/m to be known, μ can be calculated. F. J. W.

3276. Phenomena Preceding Lightning. A. McAdie. *Monthly Weather Rev.* 56. *pp.* 219–220, *June*, 1928.

The author states that the click preceding a lightning flash is a common occurrence at Blue Hill Observatory, this click preceding the thunder by an interval which is a function of the distance of the flash for distances up to 1000 metres. The alarm displayed by animals immediately prior to a flash is probably due to the electrical strain set up and the excessive point discharge resulting. [See also Abstract 1677 (1928).] R. S. R.

3277. Quantity of Electricity Discharged in a Lightning Stroke. A. W. Simon. *Nat. Acad. Sci., Proc.* 14. *pp.* 458–460, *June* 15, 1928.

From the experimental figures of Norinder [see Abstract 533 B (1924)] and Peek [see Abstract 830 B (1925)], the author calculates the quantity of electricity discharged in one lightning stroke to be of the order of one coulomb. F. J. W.

3278. Ionisation in the Upper Atmosphere. E. O. Hulburt. *Phys. Rev.* 31. *pp.* 1018–1037, *June*, 1928. *Paper read before the Nat. Acad. Sci., April*, 1928.

A theory of the ionisation of the upper atmosphere of the earth by the ultra-violet light of the sun is developed based on known laws of pressures and constitution of the high atmosphere, ionic recombination, attachment of free electrons to neutral molecules, and diffusion of ions. It is concluded that the solar ultra-violet light is a necessary and sufficient cause of the Kennelly-Heaviside layer, and that hypotheses of other agencies of ionisation, such as charged particles from the sun, penetrating radiation, etc., are uncalled for except perhaps in unusual cases. The potential energy of the daytime ionisation in a column of the atmosphere of 1 cm.^{2} is found to be at least 1 erg, and the assumption that less than 1 % of this is liberated as light will account for the light of the night sky, or the non-polar aurora, as Rayleigh calls it. Due to diffusion of the ions along the lines of magnetic force the upper ionic spray of the ionised layer diffuses to the magnetic poles, concentrates there and causes the aurora. E. E. F. d'A.

3279. Cosmic Ray Measurements. R. A. Millikan and G. H. Cameron. *Phys. Rev.* 31. *pp.* 921–930, *June*, 1928.

A method is described which leads to greatly increased precision in the measurement of capacities of the order of one electrostatic unit. More penetrating cosmic rays than those previously found are indicated by a new absorption curve obtained in Gem Lake (9080 ft.) and Lake Arrowhead (5125 ft.) with much greater precision than hitherto possible. The new curve affords definite evidence for the existence of bands in the spectrum of cosmic rays. The measurements indicate that the cosmic rays consist chiefly of two bands about three octaves apart of mean absorption coefficients 0·35 and 0·04 to 0·05 per metre of water. The total energy of cosmic rays at the top of the atmosphere is found to be very nearly one-tenth that due to starlight and heat as computed from Seares' data. E. E. F. d'A.

DISCHARGE AND OSCILLATIONS.

3280. Theory of the Electric Discharge through Gases. P. M. Morse. *Phys. Rev.* 31. *pp.* 1003–1017, *June*, 1928.

Three general differential equations are set up which determine the average behaviour of a discharge of electricity through a gas. Approximate solutions, giving the electric field E and the concentration of electrons and positive ions, n_1 and n_2, at any distance x from the kathode, are found for several ranges of value of E. When E is large, the solution corresponds to the conditions in the kathode and anode fall spaces in a glow discharge. Equations are obtained for the potential drop V across the fall space; the current density at the electrode divided by the square of the gas pressure, j/p^2; and the thickness of the fall space times the pressure, pd. Another approximate equation is obtained when E is constant, which is the case in the positive column of a glow discharge. This solution indicates that within certain limits of pressure and current density small sinusoidal variations about the average value E_p are possible in E. These correspond to the striations sometimes observed in the positive column. The equations determining E_p and those determining the distance between striations check with the known empirical laws relating these amounts to the pressure, the radius of the discharge tube and the critical potentials of the gas used. A general discussion is given of the Faraday dark space, and the reasons are stated why it should be near the kathode rather than the anode. E. E. F. d'A.

3281. Probe Measurements in the Normal Electric Arc. W. B. Nottingham. *Frank. Inst., J.* 206. *pp.* 43–55, *July*, 1928.

Probe measurements have been made in cadmium, thallium and carbon arcs by sweeping the probe through the arc at a constant velocity and measuring the current collected by the throw on a ballistic galvanometer with different probe potentials applied. The voltage-current characteristic was analysed to get a measure of the positive ion concentration, the average electron temperature and the space potential by the Langmuir method. The kathode falls found were each equal to, or only slightly higher than, the ionisation potential of the active gas, and were 9·0 volts in the cadmium arc, 6·5 volts in the thallium arc, and 5·0 volts in the carbon arc. The last value is to be compared with the ionisation potential of the cyanogen molecule of 4·4 volts. The anode fall found in the carbon arc was 16·5 volts. These values for the carbon arc agree almost exactly with the "forward" and "back" e.m.f.'s measured by Duddell and others at the kathode and the anode, but not identified by them as the kathode and anode falls. E. E. F. d'A.

3282. Electric Explosions. H. Nagaoka and T. Futagami. *Inst. Phys. and Chem. Research, Tokyo, Sci. Papers,* 8. *pp.* 269–288, *July* 10, 1928.

In this work are described investigations on the various phases of explosions, the cinematographic study of the transition during explosions and the results of explosions of wires made in transformer oil. It is pointed out that experiments on electric explosions can only be successfully performed with condensers which withstand high voltage and show very little leakage. Full descriptive details of the experiments performed are given, and the paper is also fully illustrated with the photographs of exploded wires. J. K.

3283. Current Density of the Normal Kathode Fall. Part II. M. Reger and R. Seeliger. *Ann. d. Physik,* 86. 8. *pp.* 1089–1096, *Aug.* 25, 1928.

A continuation of an investigation previously described [see Abstract 2967 (1927)]. Measurements were extended to kathodes of varying diameter, and experiments were also made with iron kathodes and with tubes filled with H and with mercury vapour. New measurements in H with iron were made with diameters ($2r$) of the kathode ranging from 0·5 to 10 mm. and pressures between 2 and 10 mm. Hg. It was found that the current density could be shown by an expression of the form $j = a(r) \, . \, p^{b(r)}$. For the measurements in mercury vapour the whole discharge tube was placed in a bath of electrically heated oil. Curves are given showing the various values of a and b as r is changed. J. J. S.

3284. Diffraction of Kathode Rays by Mica. S. Kikuchi. *Imp. Acad. Tokyo, Proc.* 4. *pp.* 271–278, *June*, 1928.

The Thomson experiment [see Abstract 1355 (1928)] was repeated, using mica plates of thickness estimated to be of the order of 10^{-4} mm. For the thinner plates a pattern was obtained consisting of three families of parallel lines inclined to each other at angles of 60°, some of the intersection points being marked by spots of enhanced intensity. The fact that continuous bands rather than spots were obtained is explained by assuming the mica so thin that the diffraction lattice may be treated as effectively two-dimensional. The variation in the linear dimensions of the pattern with the accelerating potential of the incident electrons was found to accord with the predictions of the wave theory. Using thicker plates patterns consisting of four elements, *viz.*, spots, rings, black and white lines, appeared on the plates. A complete explanation of all the details of these patterns is not given, but it is suggested that for kathode rays one and three dimensional effects of a group of diffracting atoms may play separate parts, whilst in the case of X-rays the latter effect is alone pronounced. W. S. S.

3285. Scattering of Kathode Rays. B. F. J. Schonland. *Roy. Soc., Proc.* 119. *pp.* 673–680, *July* 4, 1928.

It is shown that the author's recent kathode-ray scattering experiments [see Abstract 1111 (1927)] were not suitable for an adequate test of the relativity correction to the orbit of a β-particle deflected by an atomic nucleus, owing to the effect of radiation and of the spiral form the orbit may take. The full relativity correction, disregarding radiation loss, is developed and used to estimate the amount of scattering to be expected. If radiation takes place the scattering will be increased. The ratio of the observed to the calculated amount of scattering is found to be 1·20 on a reasonable assumption as to the subsequent history of an electron describing a spiral orbit. A. W.

31
28

3286. Electron Emission in Intense Electric Fields. R. H. Fowler and L. Nordheim. *Roy. Soc., Proc.* 119. *pp.* 173–181, *May* 1, 1928.

The emission begins to be sensible for fields of rather more than 10^7 volts/cm. The emission would be already very large for fields of the order 10^8 volts/cm. These values are higher than those commonly derived from experiments, which are usually taken to indicate measurable emission for values of F about 10^6 volts/cm. The absolute determination of F is, however, very difficult, owing to the very large effect of minute surface irregularities or peaks near which larger values are found of F than those derived from the geometry of the apparatus. It seems fair to conclude that the phenomenon of electron emission in intense fields is yet another phenomenon which can be accounted for in a satisfactory quantitative manner (at least in broad outline) by Sommerfeld's theory. E. E. F. d'A.

3287. Photoelectric Threshold of Ammonium Amalgam. Sander and Nitsche. *Zeits. f. Elektrochem.* 34. *pp.* 244–246, *May*, 1928.

Ammonium amalgam was prepared by treating potassium or sodium amalgam with a saturated solution of ammonium chloride. The amalgams were exposed to light passed through various filters. The radiation passed through green glass transmitting wave-lengths ranging from 4500 to 6800 Å.U. did not produce a photoelectric effect in ammonium amalgam but did produce one in sodium and potassium amalgam. The three amalgams must, therefore, be put in the order ammonium, sodium and potassium as regards their long-wave thresholds. E. E. F. d'A.

3288. Photoelectric Effect for Submicroscopic Particles. K. Scharf. *Zeits. f. Phys.* 49. 11–12. *pp.* 827–857, 1928.

The Ehrenhaft condenser method was employed, and control experiments with parafined plates showed that any ultra-violet light falling on the condenser plates was not giving rise to pseudo-effects. Particles of Hg, Bi, Se, and S prepared by distillation in pure nitrogen, were investigated and showed for the most part normal photoelectric effect. The inverse effect (particle accumulating a negative charge) occurred only very infrequently for isolated particles, in more cases, however, for the particles of very dense swarms produced by intense heating of the generating substance. W. S. S.

3289. Photoelectric and Thermionic Properties of Iron. A. B. Cardwell. *Nat. Acad. Sci., Proc.* 14. *pp.* 439–445, *June* 15, 1928.

A preliminary report of investigations of the following phenomena: The variation of the photoelectric sensitivity of iron as it undergoes an extended process of outgassing by heat treatment; the effect of crystallographic changes on the photoelectric sensitivity of thoroughly outgassed iron; the effect of a crystallographic change on the thermionic emission from outgassed iron, and the variation of the long wave-length limit through the outgassing process. E. E. F. d'A.

3290. Voltage-Current Relation in Central Kathode Photoelectric Cells. T. C. Fry and H. E. Ives. *Phys. Rev.* 32. *pp.* 44–56, *July*, 1928.

Considers a source of photoelectrons located on the inner of two concentric spheres. Derives the trajectory of an electron shot off at any angle with any speed. And then makes use of this information to compute the current which would be received by a small collector located anywhere on the outer sphere upon very general assumptions as to the directional distribution and velocity distribution of the photoelectrons. This theoretical study is followed by graphical presentation of results computed for several typical cases of special interest in connection with the experimental study. E. E. F. d'A.

3291. Distribution in Direction of Photoelectrons from Alkali Metal Surfaces. H. E. Ives, A. R. Olpin and A. L. Johnsrud. *Phys. Rev.* 32. *pp.* 57–80, *July*, 1928.

An experimental study of the distribution in direction of photoelectrons emitted from alkali metal surfaces irradiated by light incident at various angles and polarised in different planes. The alkali metal surfaces used were of two sorts: (1) liquid alloys of sodium and potassium, (2) thin films of potassium or rubidium on polished platinum. In all cases the alkali metal surface was at the centre of a large spherical enclosing anode, provided either with collecting tabs at various angular positions or with an exploring finger. It is found that the emission closely obeys Lambert's law, but that the ellipse by which the emission is represented, in polar coordinates, is more elongated normally to the surface for perpendicularly incident light than for obliquely, when the direction of the electric vector is in both cases parallel to the surface, and still more elongated for obliquely incident light with the electric vector in the plane of incidence. The distribution curves are all perfectly symmetrical about the normal to the surface, showing no tendency to follow the direction of the electric vector. E. E. F. d'A.

3292. Mechanism of Electron Oscillations. H. E. Hollmann. *Ann. d. Physik*, 86. 1. *pp.* 129–187, *June* 5, 1928.

Discusses the various methods of generating extremely short electromagnetic waves and describes experiments with a valve whose anode and grid were connected by parallel copper wires 2 cm. apart, and tuned by means of a bridge across the wires. Compares the oscillations thus obtained with those of the methods of Barkhausen and Kurz (BK) and Gill and Morell (GM) respectively. The shortest wave-length attained is 70 cm. E. E. F. d'A.

3293. Telephony on Very Short Waves. H. E. Hollmann. *E.N.T.* 5. *pp.* 268–275, *July*, 1928.

In the experimental arrangement adopted, the grid and anode of a tube are connected with two Lecher wires, which can be united by a sliding bridge. Between the two blocking condensers of the bridge is a thermoelement for the measurement of the high-frequency current. The grid and anode voltages are respectively + 100 and − 10 to − 20: the relations between the variations of wave-length and high-frequency current as the bridge is displaced are shown. A valve transmitter used with such a system for wave-lengths of 60–100 cm. is described, and the methods of modulation by the use of a parallel tube, and by modulating the grid and anode voltages respectively, are discussed. Finally, a transmitter for wave-lengths of 30–100 cm. is described. [See preceding Abstract.] E. T. A. R.

3294. Propagation of Hertzian Waves in the Upper Atmosphere. R. Jouaust. *Comptes Rendus*, 187. *pp.* 208–209, *July* 23, 1928.

Maintains that the current conceptions of the Heaviside layer do not fit with all the facts. Echoes of wireless waves often appear to come from regions as high as 200 to 400 km. This is the region of the aurora, and indicates the presence of clouds of electrons comparable in dimensions with the radio wave-lengths used. E. E. F. d'A.

3295. Stable "Relaxation" Oscillations of Neon Lamps. F. Bedeau and J. de Mare. *Comptes Rendus*, 187. *pp.* 209–210, *July* 23, 1928.

A neon lamp is mounted in parallel with a condenser charged through a resistance. It then lights up in flashes every time the condenser reaches a certain potential. The secondary of a transformer is now inserted in the lamp circuit, and an interrupted current governed by a tuning fork is passed through the primary. This furnishes accurately-timed flashes of definite periodicity. E. E. F. d'A.

3296. Motion of Electrons in a Valve Generating Short Electric Waves of the Barkhausen-Kurz Type. N. Kapzov. *Zeits. f. Phys.* 49. 5–6. *pp.* 395–427, 1928.

A theoretical discussion is given of the motion of electrons in a variable field due to potential variations of the grid and anode of a valve. In a special case numerical integration of the equations of motion is undertaken. It is shown that the origin of oscillations of the Barkhausen and Kurz type can be traced to variations in the grid and anode potentials which cause periodic irregularities in the electron streams between the filament and the grid and the anode. A. W.

3297. Piezoelectric Oscillations of Quartz Rods in Non-Uniform Fields. S. J. Sokoloff. *Zeits. f. Phys.* 50. 5–6. *pp.* 385–394, 1928.

Mandelstam and Papalexi have used non-uniform electric fields to excite strongly the higher harmonics in quartz rods. For this purpose electrodes in the form of combs were employed, the connections being made to one end of each electrode. The present paper gives a theoretical treatment of this problem, and formulæ are derived for the oscillation amplitude of the nth harmonic. [See also Abstract 350 (1926).] A. W.

3298. Radio Transmission Formulæ. G. W. Kenrick. *Phys. Rev.* 31. *pp.* 1040–1050, *June*, 1928. *Phil. Mag.* 6. *pp.* 289–304, *Aug.*, 1928.

A radio transmission formula is derived by summing the fields due to an infinite number of reflected waves. The problem is rigorously solved for two parallel infinitely conducting planes, and an approximate solution is derived for two concentric conducting spheres of finite conductivity. The results thus obtained are found to be in accord with those obtained by G. N. Watson in 1919 by the use of spherical and zonal harmonics. The method here employed approximates much more closely to the point of view adopted by recent workers in the radio field, and adapts itself more readily to a study of gradually varying boundaries. A modification in the coefficient of the exponential term in the Austin long-wave radio transmission formula which alters it from $(120\pi l\mathrm{I}/\lambda\rho)\ (\theta/\sin\theta)^{1/2} \exp[-0\cdot0015\rho/\lambda^{1/2}]$ to $(120\pi l\mathrm{I}/\lambda)\ (3\pi\theta/8\rho h \sin\theta)^{1/2} \exp[-0\cdot0015\rho/\lambda^{1/2}]$ is suggested by the analysis, and a theoretical justification for the $\lambda^{-1/2}$ in the exponent for the case of long-wave transmission is emphasised. The results obtained by the application of the modified formula to the long-wave transmission data obtained by Guierre are discussed, and an improvement in the agreement is found. E. E. F. d'A.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

3299. Hall Effect in Very Intense Magnetic Fields. A. Mazzari. *N. Cimento*, 5. *pp.* 215–223, *June*, 1928.

The Hall coefficient for bismuth was measured in magnetic fields variable from 11,900 to 36,500 gauss. A very pure specimen of bismuth was used, and the results show that the coefficient at first decreases and then—for fields above 29,000 gauss—becomes sensibly constant, the fall being from $-3\cdot44$ to $-2\cdot64$. J. J. S.

3300. Residual Thermoelectricity of Threads of Mercury. T. Tsutsui. *Imp. Acad. Tokyo, Proc.* 4. *pp.* 279–282, *June*, 1928. *In English.*

Mercury in a capillary tube of ordinary soda glass with an inner diameter of about 0·4 mm. and 50 cm. long was heated successively over small portions at a time by a small furnace. The e.m.f.'s observed as in the case of a metallic wire were irregular, and varied from one experiment to another, but always the degree of fluctuations of e.m.f. along the Hg capillary column seemed to diminish gradually, as the experiments were repeated with the same Hg column. It is suggested that such variable e.m.f. may be due to an effect at the contact between the Hg and the glass. When a narrower tube was inserted into the main tube it was found that the Hg in the narrower tube behaved as a different material to that in the other portion, and a sensible e.m.f. was observed at the junction. Fluctuations of e.m.f. were observed in this case also. After resting for a week the Hg capillary recovered, on resuming the experiments, the original magnitude of the e.m.f., which diminished as before. The variation of e.m.f. observed at the two ends of the narrower tube seems due to a temporary condition at contact between Hg and glass and not to the geometrical form of the cross-section. Further experiments are in progress. J. J. S.

3301. Projection Electroscope for Standardising Radium Preparations. L. F. Curtiss. *J.O.S.A. and R.S.I.* 16. *pp.* 363–366, *May*, 1928.

Description of an instrument used in the radium standardising laboratory at the Bureau of Standards. The instrument is a gold-leaf electroscope with a short quartz fibre attached to the leaf for convenience in reading under high magnification. The image of the fibre, magnified 100 times, is projected on a ground-glass scale about 4 ft. from the electroscope. The electrical and mechanical details are fully described, and are illustrated by four diagrams and a photograph of the general layout. The arrangement has the advantages of minimising eyestrain and of allowing adequate protection against the physiological effects of the γ-radiations.

H. R. R.

3302. Manufacture of Potassium-Hydride Photoelectric Cells. W. B. Nottingham. *Frank. Inst., J.* 205. *pp.* 637–648, *May*, 1928.

Describes in detail a procedure by which photoelectric cells can be easily produced in the laboratory with a fairly high degree of certainty that they will be successful and reasonably uniform in their sensitivity.

E. E. F. d'A.

3303. Summation Actinometer with Photoelectric Cell. I. Ranzi. *N. Cimento*, 5. *pp.* 234–238, *June*, 1928.

A description is given of an actinometer formed by a photoelectric cell with potassium hydrate (or similar salt of an alkaline metal) the kathode of which is joined to the negative pole of a primary battery or accumulator, the anode being united to the positive pole of the battery across a silver nitrate voltmeter. From the quantity of silver deposited in the voltmeter the mean current which has passed during a certain period of time is obtained. The cell is furnished with a filter allowing only monochromatic light to pass, so that a comparison may be got between a standard Hefner candle and monochromatic sunlight. From the measured strength of current the intensity of the monochromatic solar radiation may be obtained, and from this the mean value of the illumination or of the so-called summation of the light. J. J. S.

3304. Large Electromagnet of the Academy of Sciences. A. Cotton. *Comptes Rendus*, 187. *pp.* 77–89, *July* 9, 1928. *R.G.E.* 24. *pp.* 317–322, *Sept.* 1, 1928.

A description of the great electromagnet of the Academy is given, with illustrations and drawings. The magnet is designed with conical pole pieces of cobalt steel to produce a field of about 46,000 gauss in an air gap 2 cm. long, when excited with 400 amperes at 240 volts, and weighs nearly 120 tons. A pit under the electromagnet allows spectrographic work to be carried out at constant temperature. The pole cores are conical, carrying water-cooled windings totalling 1250 turns, the tips are separately adjustable, special provision being made to bring the pole-pieces accurately co-axial in order to obtain the strongest fields. The whole framework is very massive to stand the pull of over 100 tons, and is about 6·3 metres long by 2·75 metres wide and high, each pole being moved by four screws gear-driven from a motor. W. C. S. P.

3305. Torsion Magnetometer. J. Ewles. *Leeds Philosoph. and Lit. Soc., Proc.* 1. *pp.* 294–300, *July*, 1928.

This instrument has been designed primarily for use in elementary laboratories for the measurement of magnetic forces. It consists of a short cylindrical magnet of cobalt chrome steel about ⅛ in. thick and ½ in. long, suspended by a 3-in. length of phosphor bronze strip from a torsion head. The magnet is carried in a brass collar to which are fixed two light arms of brass at right angles to each other. These just skim the surface of a little thin oil contained in the base, and render the movement dead beat and quick setting. Details are given of the method of use for simple magnetic measurements. A. W.

3306. Application of a Valve Amplifier to the Measurement of X-Ray and Photoelectric Effects. C. E. Wynn-Williams. *Phil. Mag.* 6. *pp.* 324–334, *Aug.*, 1928.

In a previous paper [see Abstract 2987 (1927)] the author showed how to compensate a pair of valves arranged in a balanced bridge so as to be independent of fluctuations of filament voltage. The present paper discusses the experimental arrangement of such a balanced bridge and gives some details concerning the precautions necessary. It is particularly important to screen all leads very completely, and to keep all connections as short as possible. Unless screening is very complete, there is danger of a high-frequency pick-up causing serious disturbances. Under suitable working conditions the bridge is particularly suitable for measuring directly ionisation currents due to X-rays or currents from a photoelectric cell. G. E. B.

3307. Action of the Disc of the Resonance Telephone. F. Bergtold. *Zeits. Instrumentenk.* 48. *pp.* 400–404, *Aug.*, 1928.

The resonance telephone considered consists of a tongue which is excited by a polarised magnet system. The coils of the magnet system traversed by the alternating current are connected with a condenser in series, whereby the electric tuning approximately accords with the tongue resonance. In order to be able to study the occurrences in such a resonance telephone it is convenient that the disc vibrator should be converted into electrical magnitudes. A new substitution arrangement by which this can be done, and the behaviour of the telephone more clearly explained, is discussed in this paper. J. J. S.

3308. Capacity Measurement Method. W. van B. Roberts. *Frank. Inst., J.* 205. *pp.* 699–701, *May*, 1928.

The capacity to be measured is connected in parallel with a standard condenser and a suitable inductance. This circuit is coupled to a triode oscillator arranged to give a beat note in a radio receiver by means of a suitable heterodyne. Under suitable conditions of coupling bringing the circuit with the unknown capacity into tune with the oscillator causes a discontinuous change in pitch of the heat note. The setting of the standard condenser for which this occurs both with and without the unknown capacity in parallel gives from a difference of the two readings the value of the unknown capacity. F. S. B.

3309. Electric Surges in Coils. W. Rogowski. *Arch. f. Elektrot.* 20. *pp.* 299–308, *July* 19, 1928.

A description is given of a study of the effects observed in helical coils subjected to sudden high potentials, a kathode-ray oscillograph being used. A number of interesting photographs are given showing the surge potentials in special coils. A. W.

3310. Calculation of the Coefficient of Self-Induction. D. Graffi. *Elettrotecnica,* 15. *pp.* 598–600, *July* 25, 1928.

Neumann's formula for the coefficient of self-induction L lacks practical usefulness, for it gives for it an infinite value. The author first shows that this is the case and then gives a calculation for the value of L which may be serviceable in practical work. A particular case is considered, that of a cylinder traversed by a continuous or alternating current parallel to its axis, and this is then extended to more general cases. J. J. S.

ALTERNATING CURRENTS AND MAGNETISM.

3311. Repulsion between Electric Currents and their Induced Eddy Currents in Parallel. C. Barus. *Nat. Acad. Sci., Proc.* 14. *pp.* 542–544, *July,* 1928.

Application of the interferometer U-gauge to the estimation of the Elihu Thomson forces between an annular coil carrying alternating current and the mercury in the U-gauge. The smallness of the forces and the development of oscillations in the mercury columns prevent accurate observation of the interference fringes; complications are introduced by temperature effects, and there are other unexplained anomalies. These factors have prevented the instrument from being used for the rating of dielectric constants—for which it was originally designed. H. R. R.

3312. Effect of Temperature on the Magnetisation of Single Iron Crystals. Part IV. E. Dussler. *Zeits. f. Phys.* 50. 3–4. *pp.* 195–214, 1928.

The temperature effect was investigated, for magnetisation parallel to the tetragonal and digonal axes, between the temperature of liquid air and that of the Curie point. The effect of low temperature is an increase in the hysteresis loss and a rise in the remanent magnetisation. The saturation intensity varies from 1714 to 480 for a temperature change from 293° to 1029° abs. The higher the temperature, the smaller the field required to produce saturation. [See also Abstracts 482 and 3206 (1927).] G. E. A.

3313. Magnetic Properties of Cobalt. Margarete Samuel. *Ann. d. Physik,* 86. 5. *pp.* 798–824, *July* 28, 1928.

The test specimens were two bars obtained from different sources; one bar contained 1·33 and the other 1·5 % of iron. There were determined the ordinary and the ideal magnetisation curves [see also Abstract 239 (1916)], the reversible permeability and the coercive force as a function of the temperature. Although subjected to similar thermal treatment, the bars exhibited differences in magnetic quality. One bar became magnetically harder by cooling to − 185° C. As with iron, steel and nickel the reversible susceptibility is a one-valued function of the magnetisation, but Gans' law for corresponding states does not hold for cobalt. Between − 185° and 400° the coercive force is a single-valued function of the temperature, but not the same as that found by Gans for the other magnetic metals. G. E. A.

3314. Magnetic Susceptibility of Ozonides. V. I. Vaidyanathan. *Indian Journ. Phys.* 2. *pp.* 422–433, *July* 31, 1928.

The ozonides, or compounds of ozone with unsaturated hydrocarbons, acids, etc., are bodies in which the ozone molecule retains the chemical identity of the free molecule to a large extent, and whilst the diatomic molecule of oxygen is strongly paramagnetic, these ozonides are all diamagnetic. Owing to their unstable and explosive properties, the substances were examined, as powders, liquids or solutions, at low temperatures, the method being that of the Curie balance. For phenanthrene diozonide, diphenyl tetraozonide, naphthalene diozonide, anthracene ozonide and oleic acid ozonide peroxide, specific susceptibilities were found which varied from $-0\cdot47 \times 10^{-6}$ to $-0\cdot68 \times 10^{-6}$; the O_3 molecule has a susceptibility about -25×10^{-6} per gramme molecule. The structure of molecule required to bring magnetic properties into agreement with chemical activity is discussed. G. E. A.

RADIOGRAPHY AND ELECTROPHYSIOLOGY.

3315. Electrical Fields of Physiological Origin. W. O. Schumann. *Zeits. f. tech. Phys.* 9. 9. *pp.* 315–321, 1928.

This important paper is largely descriptive of apparatus used for experimental purposes, is partly mathematical, and has numerous curves obtained by experiments. It does not, therefore, lend itself to condensation. It is a continuation of a previous paper by the author and F. Sauerbruch [see Abstract 1994 (1928)], and confirms their previous results, *i.e.*, comparative measurements with various types of valve amplification apparatus show the apparent existence of very rapidly varying electrical effects in the neighbourhood of the body during physiological processes. Previous observations of Heydweiller are confirmed, but these effects are the sum of very complicated reactions of which the Sauerbruch-Schumann effect is apparently an elementary process. B. J. L.

CHEMICAL PHYSICS AND ELECTROCHEMISTRY.

3316. Adsorption of Vapours. A. Fleischer. *Am. J. Sci.* 16. *pp.* 247–258, *Sept.*, 1928.

A critical review of the adsorption theories of Eucken, Polányi, Patrick, Zsigmondy and Langmuir. F. J. W.

3317. Selective Adsorption from Gaseous Mixtures by a Mercury Surface formed in the Mixture. M. L. Oliphant. *Phil. Mag.* 6. *pp.* 422–433, *Sept.*, 1928.

This paper presents experimental evidence which indicates that an expanding mercury surface selectively adsorbs carbon dioxide from a mixture of carbon dioxide with an excess of hydrogen or argon. The measurements show that within the limits of experimental error the carbon dioxide so adsorbed forms a monomolecular layer over the surface of the mercury. Full experimental details are included. H. H. Ho.

3318. Influence of Lyophile Colloids on the Precipitation of Salts. Agar-Agar and Lead Iodide. T. R. Bolam. *Faraday Soc., Trans.* 24. *pp.* 463–470, *Sept.*, 1928.

It has been shown that under certain conditions gelatine is able to prevent the formation of solid silver chromate by the interaction of silver nitrate and potassium chromate [see Abstracts 234 (1927), 1068 (1928)]. The influence of agar-agar on the formation of lead iodide from lead nitrate and potassium iodide was investigated. Measurements were made on the time of precipitation of lead iodide in the presence of agar-agar. Conductivity measurements were made upon similar systems, with a view to explaining the behaviour of the agar. It was found that further data from electrometric measurements were necessary before a complete discussion of the problem could be made. F. J. B.

3319. Some Physical Properties of Phenol in Benzene. L. E. Swearingen. *J. Phys. Chem.* 32. *pp.* 1346–1353, *Sept.*, 1928.

The densities of mixtures of phenol and benzene were determined at 25° C.; the relationship between density and concentration was shown to be linear. Measurements of the viscosities of phenol-benzene mixtures showed a pronounced minimum in the viscosity-concentration curve, the minimum point being more definitely marked in the dilute mixtures. The behaviour was explained by the assumption of associated phenol molecules in the more concentrated solutions, which dissociate in the more dilute solutions to give the abnormal effect. Surface tension measurements were made of the various phenol-benzene mixtures, and a minimum was found in the surface tension composition curves. The surface tension effects were explained on the basis of negative adsorption of the phenol at the phenol-benzene interface. F. J. B.

3320. Surface Tension and Solvation of Salt Solutions in Non-Aqueous Solvents. P. P. Kosakewitsch. *Zeits. f. Phys. Chem.* 136. 3–4. *pp.* 195–207, *Sept.*, 1928.

Continuation of experiments described [*ibid.* 133. pp. 1–14, March, 1928].

Typical inorganic salts increase the surface tension of water. As regards the negative capillary activity the order of the ions is Cl > Br > I, and Li > Na > K, probably in analogy to the hydration values. Addition of salt also increases the surface tension of organic solvents to a slight extent, but the order of the anions is reversed, whilst that of the kations remains unchanged. The chief solvents examined, pyridine, acetone, alcohols, formic acid and water, range as to dielectric constants from 12·45 to 81·1. The capillary rise is measured. If σ_0 is the surface tension of the pure solvent and σ the same after addition of the salt, then $\Delta\sigma = 100(\sigma - \sigma_0)/\sigma_0$. The $\Delta\sigma$ is expressed by $\Delta\sigma = aN + b$, where N is the salt concentration; in the curves the a are plotted as ordinates against the concentration, mostly of alcohol-water mixtures. The a of Na and Li salts (halides) becomes negative with increasing alcohol concentration, and passes through a minimum; there should therefore be two mixtures, the surface tensions of which would not be altered by the addition of salt. The minimum shifts in the order Na-Li and Cl-Br-I towards greater alcohol dilution; the range of solvent concentration, for which a is negative, is greater for Na than for Li, and greater for Cl than for I salts. As regards binding of the salt by the alcohol (solvation) or by the water (hydration) and the consequent decrease of the surface tension, the author refers to Seith [see Abstract 623 (1926)]. In weak alcoholic mixtures the addition of salt generally lowers the surface tension, though less than it would if there were no solvation. With higher solvent concentration the relations become complex. Thus in pure and concentrated ethylalcohol the σ increases on addition of lithium halides; at medium alcohol concentrations the salt lowers the σ; at high dilution of the alcohol there is again increase. The increase in $\Delta\sigma$ is thus proportional to the increasing salt concentration only over certain ranges. H. B.

3321. Physical Properties of Heterogeneous Ternary Mixtures. P. Mondain-Monval. *Comptes Rendus*, 187. *pp.* 444–447, *Sept.* 3, 1928.

Shows that results obtained do not support Brun's statement that there occurs, in the homogeneous zone, an important disturbance of the properties of a mixture of ethylalcohol, iso-amyl alcohol and distilled water near to the critical point. Using the same mixture as Brun, the refractive indices, which can be measured very accurately, for various concentrations do not show any discontinuities or distortions. Results obtained by others for somewhat different mixtures further support the statement that there are no changes in the properties of the mixture at the critical point. R. C. F.

3322. Equilibrium Diagram of the Copper-Silicon System. K. Matuyama. *Tohoku Univ. Sci. Reports*, 17. *pp.* 665–673, *June*, 1928. *In English. Report No.* 186 *of the Research Inst. for Iron, Steel and other Metals.*

The diagram has been determined making use of thermal analysis data, electrical resistance measurements and microscopic examination. It is of a somewhat complicated character, and it is difficult to explain its main features briefly. The original paper should be consulted. A. A. D.

3323. Anomalies of Annealing after the Cold Working of Copper and Brass. Eugène. *Comptes Rendus*, 187. *pp.* 378–380, *Aug.* 13, 1928.

Nicolau [see Abstract 1750 (1928)] has established a hardness anomaly which marks the end of the zone of germination of copper and brass. After a systematic study of the influence of annealing on the mechanical properties of these metals, the author has now established that the above anomaly not only affects the hardness but the aptitude for stamping characterised by the bend before rupture by Ericksen's test, and to a less degree the elongation; also that an anomaly exhibiting the same characteristics appears immediately before the occurrence of the germination zone. Experiments are described with illustrative diagrams. H. H. Ho.

3324. Testing Tammann's Theory of Resistance Limits by Experiments with the System Gold-Copper. M. le Blanc, K. Richter and E. Schiebold. *Ann. d. Physik,* 86. 7. *pp.* 929–1005, *Aug.* 16, 1928.

Le Blanc and Rössler had shown that Tammann's normal distribution rate was only very roughly applicable to fused crystals of (Na, Ag)Cl which were always soluble in water to a slight extent, even when the melts contained 94 mol. per cent. of AgCl. Tammann then declared that the (Na, Ag)Cl was difficult to render homogeneous, and was unsuitable for testing his rule. The authors, therefore, experimented with electrolytic copper and purified gold, fused at 1200° in Ni-resistance furnaces and Battersea crucibles in masses of at least 20 gm., kept liquid for three hours and then poured into aqueous alcohol of 50 % and rolled down to a thickness of 0·05 mm. The alloys were homogeneous, and contained from 20·87 % to 34·97 % of Cu, corresponding to the mol. fractions (mol. Cu/mol. (Au + Cu)) 0·45 to 0·625. The melting points of the alloys were near 890°; they were annealed for 25 days at 840° in a vacuum furnace, and also tested unannealed, or slowly cooled instead of quenched, in nitric acid of density 1·4, containing up to 1 % of N_2O_3, but kept at 22° to avoid atomic shifting within the lattice. Some alloys richer in copper were likewise tested by X-rays after extraction of part of the copper. The curvature of the crystals disturbed these tests, of which full particulars are given and which are discussed at length with respect to Tammann's view on the distribution of two kinds of atoms in a lattice. Crystals of CuAu and also of Cu_3Au are formed. There is no indication of a normal distribution of the atoms (stable at all temperatures), and no sharp resistance limit to dissolution by acid, independent of temperature and solvent. Many factors influence these properties, and the solubility problem cannot be discussed apart from the general theory of solubility and of crystal growth. H. B.

3325. Röntgen Analysis of Thallium-Antimony Alloys. E. Persson and A. Westgren. *Zeits. f. Phys. Chem.* 136. 3–4. *pp.* 208–214, *Sept.*, 1928.

Examining the Tl-Sb system of R. S. Williams by Röntgen rays, Barth (*ibid.*, 127. p. 113) concluded that there was an intermediate phase representing a solid solution of Tl in TlSb to which he ascribed a lattice of the CsCl type. According to Goldschmidt [see Abstract 2071 (1928)] the alloy with 10 % Sb would represent a further phase, a solution of Sb in βTl, this βTl being stable above 231°. Submitting a number of alloys to X-ray (powdered crystals) and microscopic analyses, the authors find four phases: (1) αTl, which pure has a hexagonal lattice of dense cubic packing; (2) a phase with 7 % Sb, probably a solid solution of Sb in βTl, with a face-centred cubic lattice; (3) a second intermediate phase, approximately Tl_7Sb_2, with a complex cubic lattice of 54 atoms; (4) Sb, a face-centred rhombohedron. H. B.

3326. Absorption Kinetics for Molecules attached at more than One Point. R. E. Burk and D. C. Gillespie. *Nat. Acad. Sci., Proc.* 14. *pp.* 470–472, *June* 15, 1928.

The kinetics of desorption of molecules attached to the surface by two linkings is compared with that of molecules attached by only one linking. By calculation of the rate of desorption, on the basis of the probability that a molecular vibration would break one or both linkings, it is found that singly and doubly attached molecules would leave the surface at the same rate, provided that $M(\alpha + \beta) = 2$, M being the number of vibrations of the underlying surface atoms (assumed to be all alike) per second, α the average time between the breaking and re-making of one linking, and β the corresponding time for the linking at the other end of the molecule. It is suggested that the kinetic complexity considered may be related to the rough proportionality existing between the association of substances and their boiling-points. T. H. P.

3327. Application of the Donnan Theory to the Adsorption of Ions by Colloidal Silicic Acid. P. B. Ganguly and S. Krishnamurti. *Faraday Soc., Trans.* 24. *pp.* 401–405, *July*, 1928.

An ion adsorbed by a colloidal particle gets fixed to it and may be treated as a non-dialysable ion. Thus, if a colloidal solution having a preferential adsorption for one of the ions of an electrolyte such as hydrochloric acid is placed inside a semi-permeable membrane, the electrolyte being outside the membrane, it is possible to calculate from the Donnan equilibrium equation the amount of ions adsorbed by the colloidal particles from the acid if, at equilibrium, the activities of the hydrogen ions inside and outside of the membrane, and also the activity coefficient of the acid in the outer solution, are determined. The colloid chosen must be fairly incapable of diffusion through the membrane, and must keep stable in contact with the solution of the electrolyte. The results of the authors' experiments, made with colloidal solutions of silicic acid prepared in various ways, show that the amount of ions adsorbed usually increases with the activity of the acid from which the ions are adsorbed. The colloidal silicic acid prepared from silicon tetrachloride shows preferential adsorption for chlorine ions, whereas that made from methyl silicate exhibits a preference for hydrogen ions. T. H. P.

3328. X-Ray Investigation of the Formation of Martensite. K. Honda and S. Sekito. *Tohoku Univ. Sci. Reports,* 17. *pp.* 743–760, *July,* 1928. *In English. Report No.* 189 *from Research Inst. for Iron, Steel and Other Metals.*

It has been long known that there are two kinds of martensite, α and β, and that the former is less stable and more easily attacked by acid than the latter. Recently by X-ray analysis it is also found that beside the body-centred cubic martensite a body-centred tetragonal martensite with an axial ratio $c/a = 1 \cdot 07$ is found in quenched steels. The present investigation shows that the former martensite, which is more stable than the latter and is to be identified with β martensite, is found in the inner portion of a quenched specimen; while the latter martensite, which is to be identified with α martensite, is always found in the surface layer of the specimen. The mechanism of the formation of these martensites from austenite during a rapid cooling is explained atomistically. The cause of the diffusion of spectral lines of martensites is also explained on the basis of the distortion of the iron lattice due to the great internal stress caused by the carbon atoms present within it. AUTHORS.

3329. Mechanism of Carbon Penetration in the Cementation of Iron and Steel. G. Takahashi. *Tokohu Univ. Sci. Reports,* 17. *pp.* 761–782, *July,* 1928. *In English. Report No.* 190 *from the Research Inst. for Iron, Steel and Other Metals.*

The present writer shows by several experiments that the mechanism of the carburisation in iron and steel is not due to the diffusion of carbon monoxide gas, as has been usually believed, but to the direct diffusion of the nascent carbon atoms produced by the decomposition of this gas. AUTHOR.

3330. Equilibrium Diagram of the Aluminium-Calcium System. K. Matsuyama. *Tokoku Univ. Sci. Reports,* 17. *pp.* 783–789, *July,* 1928. *In English. Report No.* 191 *from the Research Inst. for Iron, Steel and Other Metals.*

The equilibrium diagram of the system aluminium-calcium is established with the following results: The system has two compounds with the formulæ $CaAl_2$ and $CaAl_3$; the former shows the maximum melting-point on the liquidus—1079° C., while the latter is formed at 700° C. by the peritectic reaction between the melt and the former compound. The alloys between Al-$CaAl_3$ and $CaAl_2$-Ca undergo two eutectic reactions, occurring at 7·55 % Ca and 616° C., and at 73·0 % Ca and 545° C. respectively. Calcium dissolves in solid aluminium, the maximum solubility being 0·6 % at about 600° C. and 0·3 % at ordinary temperature. AUTHOR.

3331. Gaseous Combustion at High Pressures. Part X. D. M. Newitt. *Roy. Soc., Proc.* 119. *pp.* 464–480, *June* 1, 1928.

Data previously obtained [Abstracts 1961 (1924); 2403 (1925)] have been submitted to systematic survey. In general, the revised figures for the maximum temperatures attained in theoretical hydrogen-air and carbonic oxide-air explosions do not differ materially from those previously estimated in cases where the initial pressure did not exceed 25 atmospheres, but at all higher pressures the newer determinations are lower than the old, the divergence increasing with the initial pressure. This circumstance is due to the fact that a co-volume correction is now made in respect of the maximum pressure obtained in each explosion. In the earlier papers the view was expressed that, in the explosions considered, the dissociation of steam at maximum pressure was practically negligible, while that of carbon dioxide was fairly constant at about 5 % throughout the whole series of carbonic oxide-air explosions. The revised figures now given generally confirm these estimates; those for steam show a 2·2 % dissociation at an initial pressure of 3 atmospheres, this diminishing regularly to 1·0 % only as the initial pressure is raised to 175 atmospheres. The new figures for carbon dioxide vary from 4·7 to 5·6 %. A remarkable feature of the observed explosion data is the unexpectedly large increase of the ratio $P_m : P_i$ with the initial pressure. This phenomenon is undoubtedly due partly to the increasing opacity of the gaseous medium with pressure to the radiation emitted during the explosion. It is now shown, however, that about 50 % of this effect in the case of the carbonic oxide explosions and about 75 % of it in the hydrogen explosions may be ascribed to the co-volumes of the components of the gaseous media in question, and that the correction on this account is a function, not only of the initial pressure, but also of the maximum temperature attained in the explosion. T. H. P.

3332. Combination of Hydrogen and Oxygen by Electric Discharges. R. D. Rusk. *Phys. Rev.* 32. *pp.* 287–292, *Aug.*, 1928.

Combination of hydrogen and oxygen in the Geissler discharge, low-voltage arc and electrodeless discharge.—It was noted that combination ceased to be explosive in equivalent volumes of the two gases at pressures below 3 cm. Logarithmic decrease in pressure was obtained in equivalent volumes in the Geissler discharge for constant current, whereas excess oxygen increased and excess hydrogen decreased the rate of combination, a similar change in rate having been noted by Lind in his α-ray experiments.

Number of water molecules former per pair of ions, as function of pressure.—From a consideration of the number of ions present in the Geissler discharge it appears that the number, *k*, of water molecules formed per pair of ions at the lower pressures is much less than unity, but that it increases with increasing pressure and may approach the value obtained by Lind at somewhat higher pressures. The pressure at which *k* approximates unity is such that the time between molecular collisions is of the order of magnitude of the life of an excited hydrogen atom. This is consistent with the view that combination may be due to some similar type of excitation produced by a process secondary to ionisation. AUTHOR.

3333. Action of Salt Mixtures on Copper. A. Launert. *Comptes Rendus*, 187. *pp.* 206–207, *July* 23, 1928.

To verify the hypothesis that the changes of resistance, density, etc., produced by salts on metals may be explained by the absorption of salt vapours, the author has heated copper rods in the following salt mixtures: $KCl\text{-}S_2Cl_2$, $KCl\text{-}BaCl_2$, and $S_2Cl_2\text{-}BaCl_2$. Experimental details are included, and from the results it would appear that by a study of the action of salt mixtures upon copper chemical combinations may be discovered between the salts at their eutectic points. H. H. Ho.

3334. Problems of the Energy Transfer in the Kinetics of Chemical Reactions. C. N. Hinshelwood. *Phys. Zeits.* 29. *pp.* 556–558, *Aug.* 15, 1928. *Abstract.*

As many chemical reactions proceed at measurable rates, not all the molecules will at any particular moment be equally reactive. For a large number of reactions the velocity of reactions is given by the rule of Arrhenius, $K = Ae^{-E/RT}$, where E is the heat of activation and A is not dependent upon temperature. The activated molecules, which are alone reacting, will, by collision or absorption of radiation, have received an excess of energy above their mean energy; this energy is the heat of activation. The author discusses unimolecular, quasi-unimolecular, bimolecular, etc., gas reactions [see Abstracts 823, 824 and 1936 (1927) and 1761 (1928)], photochemical and chain reactions, and points to the importance of the solution of three problems: the molecular diameter on the quantum theory; the dynamics of the electrons of chemical combina-

V. 19

tion; the pronounced changes in entropy apparently produced by traces of catalysts or impurities. H. B.

3335. Chemical Equilibrium in the Vapour of a Mixture of Paraffins and Unsaturated Hydrocarbons. H. A. Wilson. *Roy. Soc., Proc.* 120. *pp.* 247–251, *Sept.* 1, 1928.

The present work is on the lines of that disclosed in a previous paper [see Abstract 765 (1928)] except that in the present investigation unsaturated hydrocarbons containing one or more double bonds as well as paraffins are supposed to be present in the mixture. A table is given showing the calculated equilibrium percentages of the total pressure due to unsaturated hydrocarbons when liquid and vapour are both present at several temperatures and pressures. Doubling the pressure appears to diminish the unsaturated compounds in the vapours to about one-third, while raising the temperature to 50° F. appears to about double them. J. K.

3336. Decomposition of Ammonia by High-Speed Electrons. J. C. McLennan and G. Greenwood. *Roy. Soc., Proc.* 120. *pp.* 283–295, *Sept.* 1, 1928.

The decomposition of ammonia by high-speed electrons was studied in a modified form of the Coolidge tube. The hot filament was maintained at a high negative potential, and the copper tube window and end piece were at a high positive potential. The reaction vessel was filled with carefully purified ammonia gas, the kathode rays were switched on and the bombardment of the gas was carried out for a definite period of time, usually 2½ minutes. The rays were then turned off and the pressure of the gas measured. The results showed that the percentage decomposition of the ammonia was a linear function of the applied voltage. The decomposition was very sensitive to changes of pressure. The presence of excess of nitrogen had the effect of increasing the quantity of ammonia decomposed when equilibrium was established. The presence of an excess of hydrogen decreased the amount of decomposition. F. J. B.

3337. Influence of the Intensity of Incident Light on the Velocity of Some Photochemical Reactions. B. K. Mukerji and N. R. Dhar. *J. Phys. Chem.* 32. *pp.* 1308–1330, *Sept.*, 1928.

It has been found that the velocities of the reactions between sodium formate and iodine, Rochelle salt and bromine, quinine sulphate and chromic acid are proportional to the square of the intensity of the incident light; those of the reactions between iodine and potassium oxalate, ammonium oxalate, sodium malate, or sodium nitrite, ammonium oxalate and mercuric chloride in the presence of eosin to the square root of the intensity of the incident light; those of the reactions between chromic acid and oxalic acid, sodium citrate and iodine, sodium formate and mercuric chloride, the oxidation of iodoform in benzene solutions and the bleaching of dicyanin to the first power of the intensity of the incident light. The velocity of the reaction between potassium permanganate and oxalic acid is proportional to a power of the intensity which is less than a half. A theoretical discussion of these results is given. F. J. W.

3338. Photogalvanic Cell with Silver Iodide Electrodes. S. Iimori, T. Takebe. *Inst. Phys. and Chem. Research, Tokyo, Sci. Papers, No.* 139. *pp.* 131–160, *April* 25, 1928. *In English.*

Describes a photogalvanic cell consisting of two electrodes of iodised silver immersed in an electrolyte, and studies the effect of temperature, illumination and wave-length upon the photoelectric potential developed. The direct conversion of light into current is small, the efficiency being less than 1 %. Describes in detail some cells used for photometric purposes, and the somewhat elaborate precautions necessary to maintain their efficiency. E. E. F. d'A.

3339. New Investigations on Cells which Contradict the Second Law of Thermodynamics. V. Karpen. *Comptes Rendus*, 187. *pp.* 418–420, *Aug.* 20, 1928.

A cell consisting of platinised platinum as one electrode and a second electrode of Acheson graphite, with a saturated solution of sodium hydrate as electrolyte, has an e.m.f. of about 0·5 volt, the graphite being positive. When the concentration of the caustic soda is reduced to nil the graphite becomes negative. A special cell was designed to investigate the reversal. It was found that air dissolved in the electrolyte modified the e.m.f., but in air free distilled water the e.m.f. was not zero. The application of the second law of thermodynamics to such a cell demands a reaction between the graphite and the water which is improbable. The behaviour of the cell cannot be explained by any possible chemical reaction, but the result of the investigation seems to contravene the second law of thermodynamics.

F. J. B.

3340. Electrometric Titration Curves of Dibasic Acids. Part II. β-Substituted Glutaric Acids. R. Gane and C. K. Ingold. *Chem. Soc., J. pp.* 2267–2272, *Aug.*, 1928.

The authors described a method of obtaining approximate measurements of the distance between the carboxyl groups of dibasic acids by utilising the hydrogen-ion activity determinations, during neutralisation with a strong base, in a previous communication [see Abstract 2866 (1928)]. The work was continued and the titration curves for a number of substituted glutaric acids were determined. The results in general were in accord with the theory, but the distance between the carboxyl groups was greater for glutaric acid than for the substituted glutaric acids.

F. J. B.

3341. Dropping Mercury Electrode for Use in Chemical Analysis. E. Bayle and L. Amy. *Comptes Rendus*, 186. *pp.* 1610–1612, *June* 11, 1928.

The dropping mercury electrode avoids the polarisation of the electrode during electrolysis. The use of the mercury electrode in analytical chemistry is accompanied by certain difficulties which render the accuracy of the estimations somewhat doubtful. The dropping mercury sets up oscillations, and unless the mercury is very pure, the resistance at the dropping capillary tube increases and reduces the current. In order to avoid these defects a special form of dropping mercury electrode was devised, in which the stream of mercury was more rapid, so that the oscillations could not be noticed, and a means of maintaining a constant mercury level was introduced. With these modifications it was found possible to estimate small quantities of antimony, cadmium and bismuth in alloys, and very small amounts of the alloys were required for the determinations. F. J. B.

3342. Electrometrical Determination of the Concentration of Calcium Ions with the help of Electrodes of the Third Kind. M. H. Corten and I. Estermann. *Zeits. f. phys. Chem.* 136. 3–4. *pp.* 228–230, *Sept.*, 1928.

In this paper is described a convenient method of determining the calcium ion concentration by the electrometrical method, use being made of the systems:—

$$\text{I. } \mathrm{Ag/Ag_2C_2O_4/CaC_2O_4/Ca^{\cdot\cdot}}.$$
$$\text{II. } \mathrm{Zn/ZnC_2O_4/CaC_2O_4/Ca^{\cdot\cdot}}.$$

J. K.

3343. Electrode Potential and Replacing Power of Manganese. H. D. Royce and L. Kahlenberg. *Am. Electrochem. Soc., Trans.* 50. *pp.* 281–298; *Disc.*, 298–300, 1926.

Potential measurements were made of manganese following the method suggested by Neumann, but the results were unsatisfactory. Accordingly, electrodes of manganese amalgam were prepared, whose surface could be continually renewed by stirring, taking particular pains to omit all oxidation. Good reproducible potential values were obtained, which are several hundredths of a volt higher than those reported by Neumann. In the normal sulphate, the potential for manganese is 1·449 volts. The effect of the concentration of the manganese in the amalgam was investigated. The potential of the amalgam increases as the per cent. manganese in the amalgam is increased, until a value of 1·45 volts is obtained at a concentration of 1·2 % manganese in the amalgam. From there on, further increases in the manganese content result in no change in the potential value of 1·45. Manganese will replace out of solution other metals, whose potentials are more noble than that of manganese, including zinc, cadmium, iron, cobalt, nickel, lead, copper and silver. AUTHORS.

3344. Electrochemical Chlorination and Bromination of Benzene. C. W. Croco and A. Lowy. *Am. Electrochem. Soc., Trans.* 50. *pp.* 315–326; *Disc.*, 326–331, 1926.

Experiments have been conducted to study the halogenation of benzene. It is possible to chlorinate benzene by stirring it with concentrated hydrochloric acid and electrolysing. The main product is chlorobenzene. This investigation showed that the amount of chlorobenzene was the same in both the electrolytic and the non-electrolytic experiments. The electrolytic method, however, gave a small amount of higher chlorinated products, which were not found in the non-electrolytic method. Therefore, it is concluded that the principal action of the chlorine generated electrolytically was electrochemical in nature, along with a slight amount of electrolytic action. In the case of bromination, the electrolytic and non-electrolytic experiments produced bromobenzene in about equal amounts, and this was the only product observed. This reaction is an electrochemical one. AUTHORS.

3345. Electrolytic Oxidation of Para-Bromotoluene and Ortho-Nitrotoluene. J. F. Conn and A. Lowy. *Am. Electrochem. Soc., Trans.* 50. *pp.* 333–344; *Disc.*, 344–348, 1926.

Para-bromotoluene and *o*-nitrotoluene were subjected to electrolytic oxidation in dilute nitric acid solution, of such a concentration as would bring about only slight chemical oxidation. Para-bromotoluene was converted to *p*-bromobenzoic acid with excellent yields. The favourable conditions are: (*a*) an electrolyte of 20 % nitric acid; (*b*) platinum electrodes; (*c*) vigorous stirring; (*d*) a current density of 0·50 amp. per sq. dm.; and (*e*) temperature of 100° C. Ortho-nitrotoluene was converted to *o*-nitrobenzoic acid in low yields. A resinous material, oxalic acid and carbon dioxide were the other products formed on oxidation. No solvents were used. AUTHORS.

3346. Electrochemical Reduction of Indigo. J. Nevyas and A. Lowy. *Am. Electrochem. Soc., Trans.* 50. *pp.* 349–360; *Disc.*, 360–370, 1926.

A quantitative study has been made of the influence of variations in current density, temperature and concentration of electrolyte upon the current efficiency of the electrochemical reduction of finely divided suspensions of indigo in solutions of sodium hydroxide, using a mercury kathode. It has been shown that the current efficiency (*a*) decreases with increasing current density, (*b*) increases with increasing temperature, and (*c*) increases with increasing concentration of alkali. An apparatus has been developed for studying electrochemical reductions, which permits of the electrolysis of a compound and the withdrawal of a sample of the katholyte in an oxygen-free atmosphere. AUTHORS.

3347. Passivity and Corrosion of Iron. L. McCulloch. *Am. Electrochem. Soc., Trans.* 50. *pp.* 379–387; *Disc.*, 387–390, 1926.

Two new instances of passivity in iron are described. Very small particles of electrolytic iron have been found not to rust as does ordinary iron. In a solution of ammonia and ammonium chloride, iron was found either to be corroded rapidly or else to be passive. An addition is attempted to the current theory of the corrosion of iron. The progressive rusting of iron is ascribed to the " catalytic " action of soluble iron salts, which are held upon the iron surface by the coating of rust. These soluble iron salts are a product of the electrolytic action which takes place over the surface of a metal when exposed to natural waters and air. Thus, the modern electrolytic theory and the old acid theory are combined into one, but the carbon dioxide to which the corrosion was attributed by the old acid theory is no longer necessary, since iron salts of stronger acids are seen to be present. AUTHOR.

3348. Hygroscopic and Catalytic Properties of Gelatinated Electrolytic Copper. C. Marie and P. Jacquet. *Comptes Rendus*, 187. *pp.* 41–43, *July* 2, 1928.

The weight of copper deposited when a solution of copper sulphate is electrolysed in the presence of gelatine is apparently greater than corresponds with the current passed. The excess is due to a mixture of gelatine with adsorbed copper sulphate and a certain quantity of water. It is found that the desiccation and moisture-absorption curves of gelatinated electrolytic copper have the same slope as those of gelatine alone under the same conditions. Such copper has special catalytic properties, and, contrary to ordinary electrolytic copper, will catalyse the synthesis of water at 100°. Its activity and structure (as shown by X-ray analysis) are comparable with those of finely-divided copper obtained by the reduction at 220° of copper oxide prepared from the nitrate. L. L. B.

3349. Metal Overvoltage Measurements with the Kathode-Ray Oscillograph. E. Newbery. *Roy. Soc., Proc.* 119. *pp.* 680–685, *July* 4, 1928.

Experiments on metal deposition made with the aid of a kathode-ray oscillograph have shown that overvoltage and transfer resistance do not occur unless a gas is liberated at the electrode. Hydrogen is always deposited along with metal when the metals of the iron group are separated electrolytically from pure solutions of their respective salts, and this gives rise to hydrogen overvoltage at the kathode. This exceptional behaviour is discussed, and it is shown to be due probably to hydration of the ions of these metals. A defect in the design of the cell previously used for these experiments [see Abstract 1209 (1917)] is responsible for erroneous values for transfer resistance, but has no effect upon the values for overvoltage.

A. W.

3350. Revision of Theory of Transfer Resistance. E. Newbery. *Roy. Soc., Proc.* 119. *pp.* 686–689, *July* 4, 1928.

Results obtained with a new type of cell [see preceding Abstract] show that (1) transfer resistance only occurs when a gas is being liberated at an electrode; (2) the highest values are obtained with very low current densities, transfer resistances becoming very small at high current densities; (3) smooth and polished surfaces give higher values than rough or spongy surfaces; (4) the conductivity of the electrolyte has no influence on transfer resistance; (5) transfer resistance increases with rise of temperature. Discussion of these results leads to the conclusion that transfer resistance is solely the electrical resistance of a film of gas covering the surface of the electrode and is not to be explained as due in part to a layer of partially exhausted electrolyte surrounding the electrode, as previously suggested. [See Abstract 2489 (1926).] A. W.

3351. Researches on the Electrolytic Oxidation of Organic Substances. C. Marie and G. Lejeune. *Comptes Rendus*, 187. *pp.* 343–344, *Aug.* 6, 1928.

It is pointed out how difficult it is to limit electrolytic oxidation reactions of organic substances, and various factors are investigated in order to determine whether it is possible to control these electrolytic organic oxidations. The oxidation of alcohol to acetic acid is investigated, attempts being made to limit the reaction at the aldehyde stage. J. K.

3352. Stream Potentials and Colloid Stability. H. R. Kruyt and P. C. van der Willigen. *Kolloid Zeits.* 44. *pp.* 307–319, *Aug.*, 1928.

Experiments of Kruyt [see Abstract 1443 (1919)] are resumed in view of similar investigations by Freundlich and Ellisch and by Lachs and Kronman. The latter suggested that the electrokinetic potential ζ should be proportional to E/P, where E is the measured potential between the electrodes in millivolts and P the pressure in cm. of Hg under which the electrolyte is forced through the capillary. This would only be true at different times if the conductivity of the liquid had remained constant. The real relation was given by Helmholtz: $\zeta = 4\pi . E\kappa\eta/PD$, where κ is the electric conductivity, η the viscosity and D the dielectric constant of the liquid. The apparatus is somewhat modified. The capillaries, varying in diameter from 0·03 to 0·09 cm., are made of ordinary glass (which behaves like a hydrogen-electrode in both acid and alkaline liquids), Jena glass

59^{III} (which behaves like an alkali metal in alkaline liquids), and also quartz glass. The reduction of the potential by the presence of alkali ions increases in the order Li^+ to Cs^+ (maximum), and also in the order $MgCl_2$ to BaC_2l; HCl has an effect of the latter order. For polyvalent metal chlorides the effect increases in the order Ce, La, $Co(NH_3)_6$, Pt, Al, $ThCl_4$. The Al-ion shows its effect at 1/100, the concentration of the other three-valent metals, and these effects are not due to hydrolysis. The discharging effect of K-ions is little influenced by the anion, except by OH, which always increases the charge even of Jena glass and quartz. The potential difference between pure water and glass could not be determined, as water is influenced by too many factors, including its history. The different effects of equivalent ions are ascribed to differences in the charge density of the ions on the glass. To remove the adsorbed polyvalent ions the glass must be washed with chromic acid. Nothing is said about colloids. H. B.

3353. Capillary Electrical Phenomena and Skin Formation of Liquid Gallium. A. Frumkin and A. Gorodetzkaja. *Zeits. f. phys. Chem.* 136. 3–4. *pp.* 215–227, *Sept.*, 1928.

In this work is given the result of an investigation on the dependence of a surface tension between gallium and various aqueous solutions on polarisation, investigated by means of a U-formed capillary electrometer, and also upon what conditions the formation of skin is dependent. The maximum value of the surface tension in normal K . Cl + 0·1 normal H . Cl is 592 absolute units and corresponds to 0·9 volts, equal to the p.d. between a normal calomel electrode and gallium. The maximum surface tension is greatly lowered by hydroxyl ions so that in a normal KOH solution a value higher than 519 absolute units is not observed. For a given polarisation the formation of a skin on the gallium surface is produced the more alkaline the liquid. J. K.

3354. Strong Electrolytes and the Dependence of Conductivity on Voltage. G. Joos. *Phys. Zeits.* 29. *p.* 570, *Aug.* 15, 1928.

The author criticises the previous work of A. Gyemant [see Abstract 2246 (1928)]. F. J. B.

3355. Experimental Determination of the Dispersion of Conductivity. Preliminary Communication. H. Sack. *Phys. Zeits.* 29. *pp.* 627–628, *Sept.* 1, 1928.

In a previous paper Debye and Falkenhagen had shown that a dependence of the conductivity of strong electrolytes on the frequency of the current used in the measurement was to be expected [Abstract 2817 (1928)]. An experimental method of measuring the dispersion of the conductivity is described. The method involves the use of a resonance circuit, consisting of self-induction and capacity, with a resistance in parallel. Measurements were made on solutions of magnesium sulphate and potassium chloride, and the results indicated that the predicted lowering of the conductivity was capable of measurement. F. J. B.